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OPHTHALMIC SURGERY

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OPHTHALMIC SURGERY

A Handbook of the Surgical Operations on the Eyeball and Its Appendages as Practiced at the Clinic of Prof. Hofrat Fuchs.

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WITH 118 ORIGINAL ILLUSTRATIONS

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PREFACE

THE forelying volume is based on the lectures which for years I have given during the courses in Ophthalmic Surgery at the Clinic of Professor Fuchs, in Vienna. Among the numerous visiting physicians who have attended these lectures, many have come from English-speaking countries, and it is in pursuance of their oft-expressed wish that this publication has been made.

In consecutive chapters there are described in detail and pictured the most important ophthalmic operations, as they are performed at the Clinic of my Chief, Hofrat Fuchs. Under his valuable guidance, my clinical education and cultivation have been acquired, and a large part of the operative procedures herein set forth I have learned from him personally. Although presented under the names of their originators, many of the operations are described with the modifications and improvements which the very extensive experience in our Clinic has gradually led us to adopt as the best routine practice. Some of the methods, however, are essentially my own: for example, the extirpation of the tear-sac. Had I not been much pressed for time, these would have been published years ago. As it is, I now for the first time publicly present them in this book.

I take this opportunity of acknowledging my indebtedness to Dr. M. Sachs, the former first assistant of the Clinic, to whose staff I was attached as a beginner in ophthalmology. To him I offer assurance of warmest thanks and sincere devotion. The drawings for the illustrations are from the skillful hand of Wenzel, who gave himself to his difficult labor with great earnestness and artistic care. To Dr. William M. Sweet my thanks are due for his friendly counsel and aid in effecting the publication of my work. I also desire to record my appreciation of the faithful and scholarly assistance of Dr. Walter L. Pyle, in reviewing the English translation of my manuscript.

JOSEF MELLER.

Vienna, June, 1908.

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ERRATA.

Fig. 16 on page 35 should be placed after Fig. 17 on page 38. It shows the condition of the lid after the Panas' operation.

Fig. 28 on page 59 must be placed on page 35 and called Fig. 16 with the following text: "Vertical section through the upper lid after tying the sutures. The tarsus has been bent forward during the closing of the skin-wound. The eye-lashes are directed forward and slightly upward." Observe, too, that the drawing is inverted.

The left drawing of Fig. 21 on page 43 must be put as Fig. 28 on page 59 with the text: "Vertical section through the inverted lower lid with the suture inserted."

The right drawing of Fig. 21 on page 43 remains Fig. 21, and should have the following text: "Vertical section through the everted lower lid with the suture inserted."

OPHTHALMIC SURGERY.

CHAPTER I.

THE LACHRYMAL APPARATUS.

EXCISION OF THE LACHRYMAL SAC.

Anatomy.— Before beginning the operation it is necessary to understand the relative position of the **internal palpebral ligament** and the anterior lachrymal crest. By placing the finger against the outer canthus and stretching both lids slightly outward in a horizontal direction, the ligament is seen at the inner part of the eye as a slightly circumscribed prominent cord immediately beneath the skin. This ligament is Y-shaped, has a horizontal part, which takes its origin from the bone, whereas the two branches of the Y are continuous with the tarsal parts of the eyelids, in this way fastening them to the bone. The lachrymal sac lies behind this so-called tendo oculi in such a manner that the top of the sac is on the level of the horizontal portion of the tendon, the sac itself extending downward from it for its entire length.

The anterior lachrymal crest is the most important landmark throughout the operation. In thin individuals it may at times be seen through the skin; in all other cases it may be found easily by permitting the finger to glide along the lower orbital edge in a direction upward and inward. In some instances it is prominent, forming a sharp border; in others, it is flat and may then be felt much better by sliding the closed forceps from the side of the nose to the inner wall of the orbit. At times it is relatively superficial; at others, much deeper. At a point where the crest forms a part of the lower bony orbital margin, it is always very prominent; its upper half, however, is usually quite flat. All these circumstances are of considerable importance in the performance of the operation. The more superficial the crest, the more readily it is reached, and the easier is the extirpation of the sac; the deeper the crest, the more difficult the operation.

The method recommended for the extirpation of the sac has proved

eminently satisfactory. It requires an accurate knowledge of the topographic anatomy of this region, and this will be discussed as the various stages of the operation are described.

In the **dissection of the structures** we commence the **incision through the skin,** beginning at a point 2 mm. above the ligament of the internal canthus and 3 mm. to the inner side of the canthus. The direction of this incision is downward and in its lower half curved slightly outward, whereas the upper half has to be perpendicular (Fig. 1). If, for instance, the upper half of the cut is not straight, but

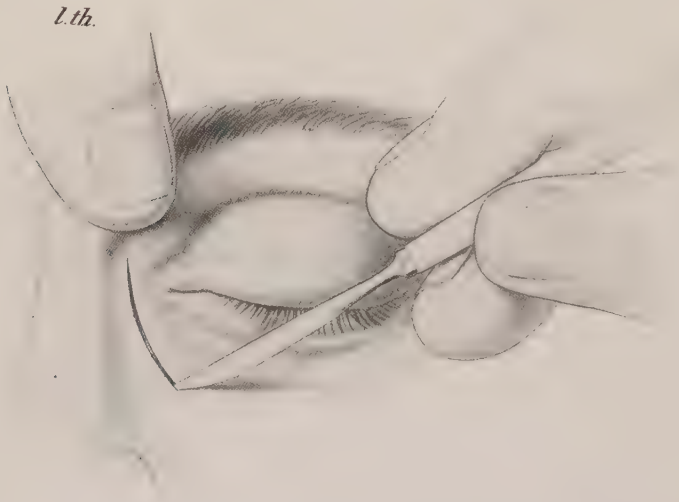

FIG. 1.—With the thumb of the left hand (l. th.) the skin is fixed, but not pulled or stretched. The cutting edge of the knife is directed vertically against the bone. The incision is downward, slightly outward and somewhat curved; 3 to 4 mm. distant from internal canthus.

curved towards the upper lid, an ugly fold of skin is frequently produced at the upper angle of the incision during the healing process. While making the incision, which, by the way, corresponds to the position of the crest, we must not pull the lids outward with the idea of making the skin tense. This would prevent the incision from being made at the desired point. It is sufficient to press the upper inner part of the skin backward against the bone with the thumb. If we use a sharp knife, slight pressure against the skin will indicate the direction of the incision, and then to deepen it more readily, the skin may still be stretched.

The length of the incision is not of much importance. The be-

ginner should make a long incision (about $1\frac{3}{4}$ cm.), as this facilitates the dissection of the sac. The expert operator usually prefers a short incision. The length of the cut varies, therefore, from 1 cm. to $1\frac{3}{4}$ cm. The further from the external canthus the incision is made, the more difficult becomes the dissection of the sac on account of the increasing distance from it.

After completing the cut, the edges of the incision are lifted up and dissected from the underlying tissue with the scalpel turned toward the canthus, so the wound may be readily opened and the **tearsac speculum** (Müller's) introduced without difficulty. This instrument is of great advantage, as it takes the place of an assistant and, by compressing the surrounding tissues, aids materially in hemostasis. The speculum is introduced closed, and to insert the hooks properly, the wound edges must first be lifted gently with forceps. Its handle is turned downward and slightly outward. The patient must keep his eyelids closed throughout the entire operation. It is, of course, necessary during the introduction of the instrument to fasten the hooks securely into the wound edges, so that no injury of the cornea be produced by any sudden jerking loose; since even an erosion might become dangerous because of the great liability of infection.

In the wound, pulled open with the aid of the speculum, is laid bare a delicate, thin, white membrane, the **superficial fascia**. Frequently this is considerably thickened in the direction of the palpebral fissure through layers of connective-tissue fibers, some of which are connected with the ligamentum canthi, and radiate from it. They must not be confounded with the true ligament of the canthus, which belongs to a deeper stratum.

In place of the scalpel, with which the main incision was made, we now employ a small, slightly curved pair of scissors, both blades of which are pointed and with these the operation is completed. With tooth forceps we pick up a fold of the superficial fascia, transfix it with one blade of the scissors and slit it throughout the entire length of the wound, pushing it back toward both margins of the same. We thus expose a layer of red fibers, the **orbicularis muscle** (palpebral portion), the fibers of which, as is known, arise from the internal palpebral ligament.

The muscle is slit up in the same manner as the superficial fascia and the fibres pushed back toward both sides with the closed scissors. We now expose to view in the floor of the operative wound a dense

white membrane, the **deep fascia,** which covers the lachrymal sac (Fig. 2). This extends from the anterior to the posterior lachrymal crest and bridges over the fossa containing the lachrymal sac. Above, below and at the inner side, the fascia becomes continuous with the periosteum of the neighboring bones; but at the posterior lachrymal crest it fuses with the orbital septum, thus completing the membrane

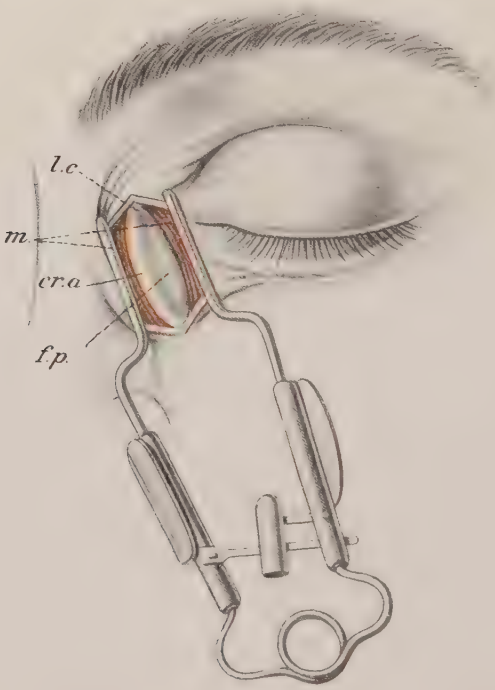

FIG. 2.—The separation and pulling to either side of the muscle-fibers (m) exposes the deep fascia (f. p.) in the wound; behind this the sac must be looked for. In the upper angle of the wound are the transverse fibers of the ligament of the internal canthus (l. c.). Through them the anterior lachrymal crest (cr. a.) can always be felt and can usually be seen.

which separates the lachrymal fossa from the orbit. The specially thickened median portions of this fascia form a prominent dense cord which has already been referred to as **internal canthal ligament.**

The fibers visible at this point may also be referred to as the anterior branch of the ligament. From it radiate bundles of fibers into the tarsus of the upper and lower lid. In contradistinction to this the portion of the fascia attached to the posterior lachrymal crest is spoken of as posterior branch of the ligament. This arrangement, useful also because of the differences in insertion of the muscle-fibers,

is understood without difficulty, when a horizontal section of the skull made through the region of the canthal ligament is viewed. By pulling the lids outward an angular folding of the deep fascia is produced, which bounds a triangular space with the lachrymal fossa. Its floor is formed by the fossa itself, its branches (anterior and posterior) by the corresponding portions of the internal canthal ligaments. In this triangle is to be found the cross-section of the lachrymal sac.

At this stage of the dissection the operator sees neither the crest, unless it is abnormally prominent, nor the lachrymal groove. To note their exact positions, he must feel around with the forceps, gliding from the side of the nose toward the orbit. The anterior lachrymal crest must serve as landmark during the entire operation. By not dissecting too near the median line he will, on the one hand, escape the mistake of incising the periosteum of the dorsum of the nose, instead of freeing the lachrymal sac; on the other hand keep from going in the wrong direction from the sac toward the orbit.

The deep fascia has to be split now with the scissors, inserting the scissors to the outer side of the anterior lachrymal crest, 1–2 mm. behind it. This is not easy, particularly on the cadaver, if we wish to escape injuring the sac. One difficulty is that no fold of tissue can be picked up for transfixion by the scissors, as the fascia is very tense. We are, therefore, forced to perforate the layer with one of the points of the scissors, holding the instrument almost parallel to the plane of the fascia. It is our custom to make the cut through the fascia 1–2 mm. behind the crest, and not, as done by others, right on the crest, so as to make the following dissection of the lateral wall easier.

As the sac lies near the fascia, its anterior wall may be injured by cutting too brusquely. This is particularly true on the cadaver, when the sac is not diseased and the walls are therefore thin and made friable through beginning decomposition. For purposes of demonstration (it may also be done with the best of success at operations), it is as well to slit the fascia along its entire length with a narrow, pointed knife (Graefe's linear knife), holding it obliquely with the cutting surface forward. I myself prefer to use the scissors for this cut. The danger of injuring the tearsac can be diminished by drawing away the fascia from it, by taking the ligament with the forceps and pulling it outward and forward. Moreover, the sac being thickened in the patient, the danger of injuring it is reduced to a minimum. However, the operator should begin with a very short cut through the fascia so that even in case the sac is injured, its perforation need not be extensive.

This cut must be completed through the whole length of the membrane, and severs the ligament of the canthus at the same time. In the slit-like opening thus produced may be seen the **lachrymal sac,** readily distinguished because of its bluish color (Fig. 3). In operating on living patients, it is not uncommon to have the anterior wall of the sac bulge through the opened fascia in the form of a hernia.

The **remainder of the operation** consists in peeling the sac out of

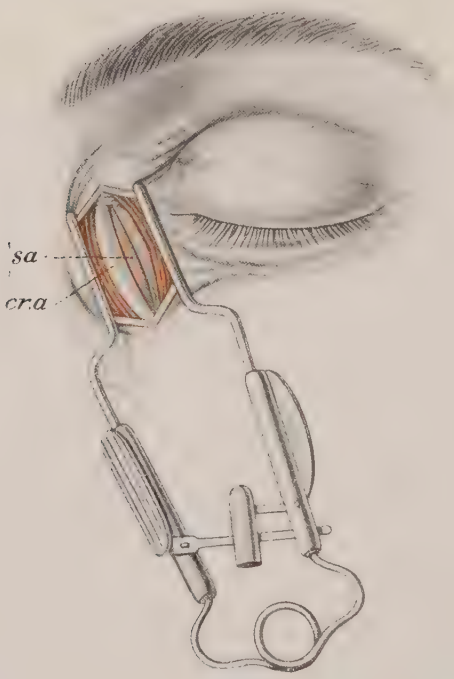

FIG. 3.—The deep fascia is incised throughout the entire length of the wound 1 mm. behind (i.e., to the side of) the crest (cr. a.). This lays bare the bluish-red lachrymal sac (sa.). The ligament of the internal canthus, which the figure shows to have been preserved, is cut through at the same time.

its coverings. From now on, the operator must constantly keep close to the wall of the sac, but must not injure the fascia or cut it away at the same time. There are no blood vessels of note in the loose tissue connecting the sac with its fascial capsule, and, therefore, during the dissecting there will be no annoying hemorrhage.

It is my usual custom first to separate the lateral wall of the sac from the fascia. For this purpose I pick up the lateral margin of the fascial wound with tooth-forceps and separate the delicate connective-tissue

fibers which connect the sac with the lateral wall of the fascia, beginning in the lower half of the wound and using for the purpose the edge of the closed scissors (Fig. 4). With a few strokes the lateral wall is separated back to the bone.

It is only when reaching the upper part that a disturbing factor is met. There is seen a bluish cord going to the lid, the **lachrymal ducts.**

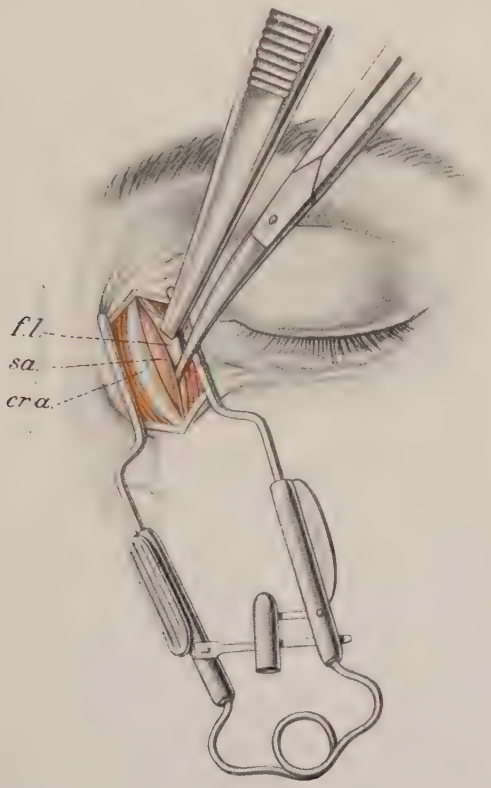

FIG. 4.—The lateral margin of the fascial wound (f. l.) is grasped with the forceps, and the closed scissors made to separate the loose areolar tissue between sac (sa.) and fascia, as far back as the bone.

These must be directly cut as close to the fascia as possible—and not dissected by the closed scissors—or else a piece of the mucous membrane will be left hanging to the fascia. Next, **the median wall of the sac** is loosened. Should the portion of the fascia left behind at the crest be too broad to free the crest easily, an incision must be made into it (i in Fig. 6). Gliding along the upper flat half of the crest with the

point of the closed scissors, it is an easy matter to separate the wall of the sac from the bone (Fig. 5). On the cadaver it is often possible to preserve the periosteum of the lachrymal bone, but on the living subject adhesions nearly always compel the removal of the periosteum with the wall of the sac. Because of this, the bone is denuded over the lachrymal fossa, but no importance need be accorded the injury. We

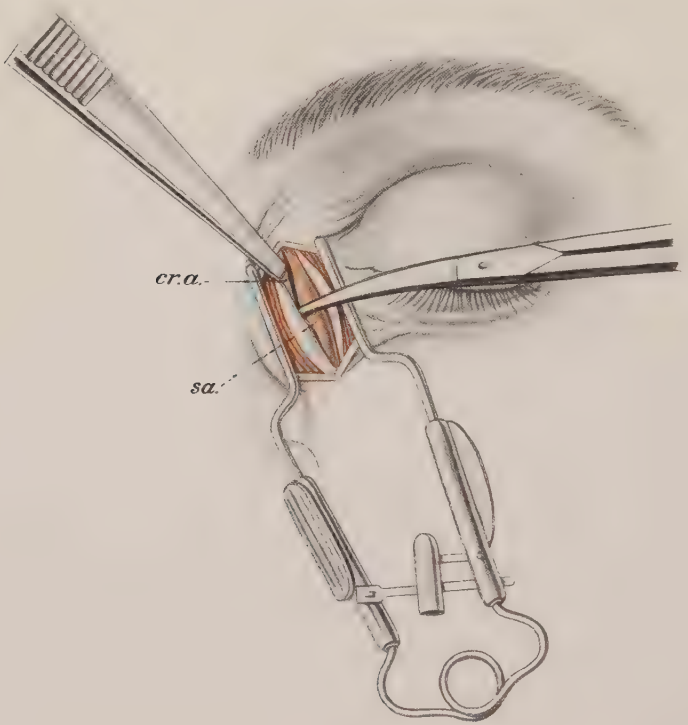

FIG. 5.—A short transverse cut (easily seen in Fig. 6 (i), while in this drawing it is pulled to one side by the forceps) into the median margin of the fascial wound exposes the anterior crest (cr. a.); this makes it easy to push the closed scissors between the bone and sac (sa.) at the upper part of the crest and to loosen the sac. The point of the scissors is directed toward the bone.

continue to proceed with the point of the closed scissors to the posterior lachrymal crest. If the upper half of the median portion of the sac had been freed, it will not be difficult to peel its lower half from behind the prominently projecting crest without injuring the sac; but if the preparation for excision has been begun at the lower steep portion of the crest, the sac will usually be injured. This is a mistake frequently committed by beginners.

The sac has now been cleared from all sides, but at the upper pole its apex is still fastened to the surrounding structures, while at the lower point it is continuous with the mucous membrane of the duct. For the first time since the operation began we can now grasp the entire sac with the forceps without fearing the risk of tearing it, and dissect

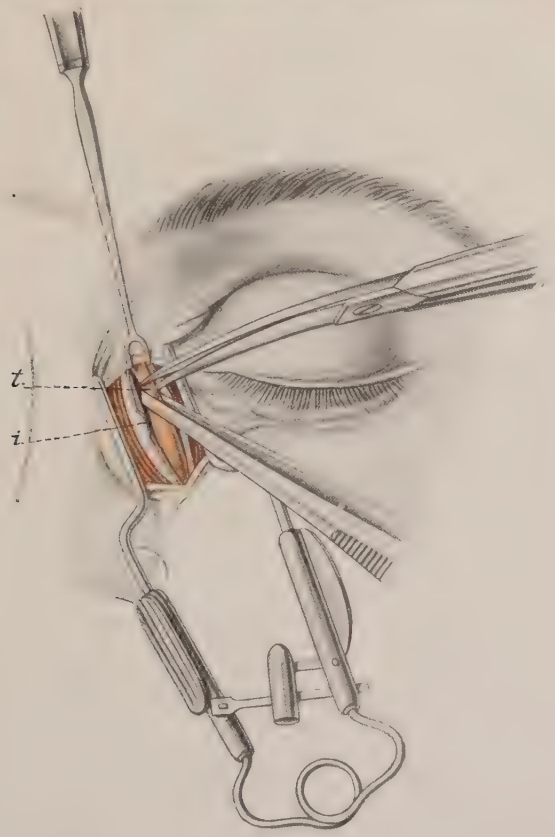

FIG. 6.—The sac, having been freed on both sides, is now for the first time grasped with forceps near its apex (t) and separated from the surrounding structures with sharp cuts of the scissors as near the sac wall as possible. The upper margin of the wound is lifted up with a double tenaculum. (See Fig. 5 (i), transverse cut into fascia.)

it out of the surrounding fascia with which its top is intimately united, making small nicks with the scissors as near as possible to the wall of the sac (Fig. 6).

This freeing of the top is a difficult part of the operation. It may readily happen if all the sac is not removed, that troublesome discharge continues. We must also be careful not to cut too much tissue

away with the apex, as in such case injury to larger blood-vessels is a common occurrence. This, by setting up considerable bleeding, will hide from view the field of operation lying beneath. In spite of the greatest caution, we sometimes have profuse hemorrhage. Because of this, I have recommended not to dissect the top until the entire sac has been completely shelled out. Even should a considerable bleeding

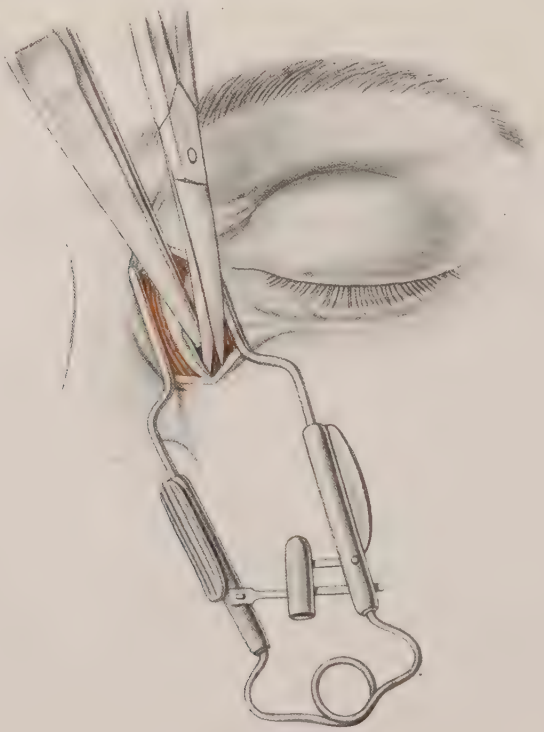

FIG. 7.—The sac, having been freed from the surrounding structures at all points except at its lowest portion, is grasped with the forceps low down; the vertically held scissors are made to cut away all the tissue attached to its anterior wall as close to it as possible until the naso-lachrymal duct is reached.

then occur, it need not cause much annoyance, as the entire sac is safely held in the forceps.

As soon as the upper portion has been freed, the entire sac may be pulled forward. Should its posterior surface still be attached to the bone by a few connective-tissue fibers, a few strokes with the closed scissors will suffice to separate them.

The next step is to **dissect the sac downward** as far as possible.

For this purpose I take hold of the sac with the forceps at as low a point as possible (Fig. 7), and, holding the scissors vertically from above downward near the wall of the sac, make several cuts in front and to both sides. These incisions will at once free the path to the beginning of the naso-lachrymal duct. Finally, the vertically held scissors are pushed down into the bony portion of the duct from the anterior or lateral surface, and in this manner the sac is cut through. While the assistant tampons the wound, I put the sac over a Bowman's probe to convince myself of the intactness of its wall, believed

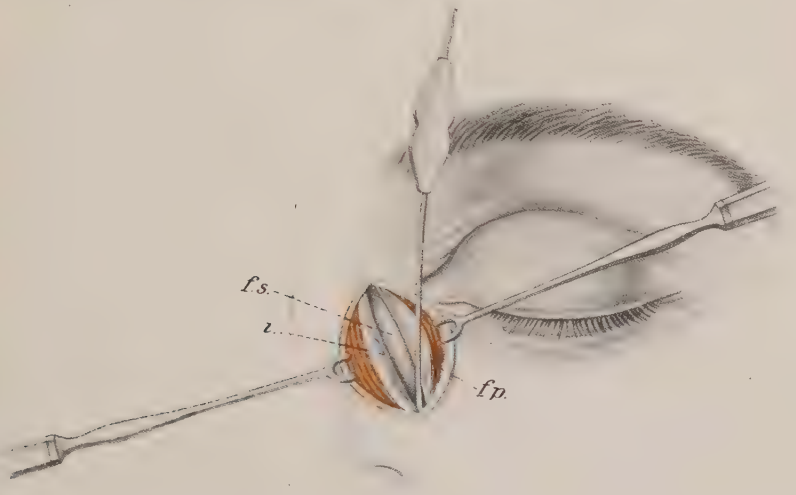

FIG. 8.—Operative Field after Completed Excision.—The small portion of the deep fascia, which has been left behind, is seen hanging to the anterior lachrymal crest; on it the transverse incision (i) is still visible. The saccal fossa (f. s.) is quite empty. The outer border is formed by the deep fascia (f. p.) where it is firmly attached to the posterior lachrymal crest; it is of a white color and has a distinct luster. Behind the anterior crest is the probe, which passes through the duct into the nose.

to be removed as a whole. If the stenosis present is complete, the sac will have the appearance of a closed cyst. The mucous membrane is brought to view only after the sac has been cut open. If we now examine the wound cavity (Fig. 8), and this should never be omitted, we will see as the median boundary the lachrymal crest and the bony lachrymal fossa, deprived of its periosteum; and as the lateral wall the **dense**, white, smooth, glistening deep **fascia** (the posterior branch of the internal ligament of the canthus), which completely separates the wound from the orbit. The sac does not properly lie within the orbital cavity, but rather outside it.

If during the operation, the surgeon loses his bearings and dissects toward the orbit, the connective tissue septum is usually injured and considerable disturbance is produced by the **orbital fat** entering the wound. This fat prevents a good view of the operative field, and retards the operation considerably by the hemorrhage which results when it is cut away.

Finally, we must **introduce a Bowman's probe into the naso-lachrymal duct.** To find its opening we place the instrument vertically against the bone immediately behind the anterior lachrymal crest and push it downward. Should the passage be closed, the instrument must be forced through the cicatricial tissue. In every instance this passage must be enlarged with a sharp curette, and all the mucous membrane found in the duct scraped away. **Curettment of the cavity** which contained the sac is not only unnecessary, if the sac has been excised properly, but even superfluous. The naso-lachrymal duct is opened with the probe in every case and made perfectly patulous by curettment, not only to prevent any possible secretion from its mucous membrane, but also to provide drainage for the wound. Before closing the wound with sutures, it must be washed out with a weak corrosive sublimate solution, care being taken that the fluid will not enter the opened naso-lachrymal duct and through it reach the mouth of the patient.

The sutures should receive especial attention. The skin of the neighborhood is thin, often easily torn, and usually curled up at the margins of the wound. If the edges of the skin are not perfectly apposed, primary union is impossible, and the relatively large wound must fill in by granulation. This means not only a retardation of the healing process, but also a broader and more conspicuous scar, while the delicate scar following a well applied suture and healing by first intention is often hardly visible.

Three sutures suffice, if the wound is of the usual length; if shorter than usual, perhaps only two. Thin **silk** is the best material for the purpose. Small **hooks,** sharp and somewhat bent, are inserted into both the upper and lower wound-angle, and the wound somewhat stretched; the thin, sharply curved **needles** containing the thread are then pushed through near the margins of the wound. The assistant must then adapt both margins, which are usually curled up considerably, with two pairs of forceps, so that margin apposes margin. He then turns the forceps to one side, so that the operator, who holds the

looped threads *parallel* to the wound, can apply the knot readily at the side of the wound. The **knots** should not be drawn too tightly, but only enough to maintain perfect adaption, as the silk readily cuts through the skin, which at this point is easily lacerated. The threads must then be cut short.

Before applying **the dressing,** the intactness of the corneal surface must be investigated. I have already called attention to the danger of an accidentally produced **corneal erosion.** The application of the dressing demands great care. The closed eye must first be covered with a small pad of gauze. This prevents the threads from other parts of the dressing passing through the palpebral fissure and eroding the cornea. The wound is then covered with a tightly rolled pad of iodoform-gauze, which is pressed slowly and with gradually increasing force against the wound, so that the wound-cavity is completely obliterated. A second small pad made of sterile gauze is placed on top of the iodoform gauze. This ensures permanent compression. The entire eye is then covered with a few layers of white gauze, and the entire dressing secured with a strip of adhesive plaster, which should be drawn tightly. Lastly the bandage is applied. The other eye remains open.

On the following day the dressing is removed for the purpose of **inspecting the cornea.** The compression-pad, however, is not removed from the wound, the outer angle of the palpebral fissure being opened but slightly with the fingers. If the case progresses satisfactorily, the second **change in dressings** is not made until the third day. On the fourth day the dressing is taken off, the stitches removed, the wound healing by first intention. Should the suture-openings bleed slightly, it will suffice to dust them with xeroform or to close them for a day with adhesive plaster.

If, however, blood has collected in the wound-cavity, the progress of the healing of the wound is retarded. The cause of the **accumulation of blood** is nearly always incomplete compression of the wound. In this complication the patient complains of pain within a day or two after the operation, and upon removal of the dressings the wound is found to be bulging, and the skin dusky red and tender to the touch. The best treatment is to remove the sutures, and to forcibly open the wound with a sharp sound or probe, so as to afford free drainage for the accumulated fluid. A small drain of iodoform gauze should be inserted and a moist antiseptic dressing applied.

Although this complication is annoying, it is usually found that in the course of a few days the wound fills with granulations and cicatrizes in a short time.

It is an entirely different matter, however, if the inflammation and accumulation are due to **retained particles of mucous membrane of the sac**—in other words, if the excision has been incomplete. This may happen occasionally to the most experienced operator; in the case of beginners it is not at all a rare occurrence.

CHAPTER II.

THE LACHRYMAL APPARATUS (Continued).

EXCISION OF THE LACHRYMAL SAC (Continued).

Before considering the complications which may arise in the performance of resection of the lachrymal sac it is necessary to discuss the proper method of making the operative area anesthetic and anemic. Practically all descriptions of this operation, refer to the extraordinarily profuse bleeding, which obscures the field of operation and makes the dissection more than ordinarily difficult. It is also generally noted that cocain does not produce a sufficient analgesia, so that many operators prefer to remove the sac under general anesthesia. The employment of **adrenalin,** however, has produced a complete revolution in this respect, and today the operation may be made almost bloodless and painless.

The following **preparatory measures** are recommended:

After the conjunctival sac has been rendered anesthetic by a few drops of 3 per cent. **cocain**-solution, the lower lachrymal duct is dilated with a conical probe and a 1 per cent. solution of cocain is injected into the sac by means of a lachrymal syringe. To prevent the fluid from flowing into the nose and eventually into the mouth, the patient should be placed in a sitting position with the head bent slightly forward. In most instances the fluid will escape through the lachrymal ducts, particularly the upper. This preliminary procedure not only anesthetizes but also cleanses the sac, which is of decided advantage, for, although the sac itself is not injured during the operation, the lachrymal and nasolachrymal ducts are cut through, and the contained secretion may escape and contaminate the wound. But even in such cases, in my experience, infection of the wound is of rare occurrence, and should it occur, it is nearly always of light character, never becoming serious.

The **technic** of the operation is as follows: The contents of a Pravaz's syringe of 1 cc. capacity will be sufficient quantity for the injection. The solution is mixed in the following manner: 8 to 9 parts of the syringe are filled with the 1 per cent. cocain-solution, the remainder, from 1 to 2 parts, filled with adrenalin or suprarenin solu-

tion (1–1000). One-third of the contents of the syringe is injected beneath the skin, the needle entering slightly below the tarsal ligament. This produces a slight bulging forward of the lachrymal-sac region, but slight massage causes the immediate disappearance of this swelling. The point of the needle is now inserted above the tarsal ligament and pushed vertically against the bone. The syringe is then twisted forward 90° so that the needle is turned in the direction of the orbit. Holding it in this direction the point is pushed forward to very near the periosteum and the second third of the solution injected, so that the tissue around the top of the lachrymal sac is made anesthetic and anemic from this injection. With the remaining solution the region immediately about the entrance into the naso-lachrymal duct is anesthetized. The injection is made in a manner similar to that previously described. The needle is inserted below the tarsal ligament in a direction vertical to the lachrymal crest; the syringe is then turned in such a manner that the needle lies parallel to the bone, when it is pushed slightly backward. Should the point of the needle enter the lachrymal sac itself, it must be pulled out somewhat and turned in a slightly different direction. This complication is readily recognized by the escape of fluid from the tear-ducts.

Immediately after completing the injection, the operation may be commenced. In a large majority of cases the bleeding is so slight that layer after layer of tissue may be removed as in the dissection of a cadaver. I have frequently resected lachrymal sacs in a few minutes without any assistance. It is really only the incision through the skin which may bleed more than expected, as occasionally the skin contains abnormally large veins. The deeper parts are always absolutely anemic.

The stated quantity of adrenalin ($\frac{1}{10}$ to $\frac{2}{10}$ cc.) suffices fully for the production of this anemia. In my experience it has never been followed by bad **after-results,** either local such as marked secondary hemorrhage or necrosis of the tissue, or constitutional. Occasionally a patient may complain of sudden distress, such as a sensation of oppression and palpitation of the heart, but these symptoms disappear shortly. In elderly patients with advanced arteriosclerosis, not more than $\frac{1}{10}$ cc. of the adrenalin should be injected, and this amount will be sufficient. Dropping the adrenalin into the wound is unsatisfactory. After the sac has been peeled out, and before the probe is inserted into the nose, some cocain should be dropped into the wound. It will

diffuse itself into the duct along the probe, and will make the curettment with the sharp spoon almost painless.

Complications. -The proper resection of the lachrymal sac is one of the most difficult operations in ophthalmology. The **difficulty,** especially for the beginner, lies **in finding the sac.** Of course, this refers only to cases in which the sac has not become so distended as to be visible as a tumor through the skin. The **anterior lachrymal crest** must always serve as a landmark throughout the entire operation; and the operator should always keep *as close as possible to the bone.* He will then refrain from looking for the sac too near the nose in the periosteum of the bone, and also avoid penetrating the orbital tissue with *which he should never even come in contact.*

The **opening of the orbital cavity,** through injury to the dividing fascia, becomes dangerous at times, as it may terminate in infection of the orbit and formation of an orbital abscess, though ordinarily it is disadvantageous only because of the **protrusion of fat** and hemorrhage from the orbital tissues. The beginner enters the orbit quite often, not from injury to the fascia, but because he fails to work toward the crest, and he dissects backward and penetrates the fat of the orbit on the outer side of the fascia, without ever having cut into it. In so doing he naturally does not find the lachrymal sac.

Should the sac be injured during the operation no importance need be attached to the accident, provided the operator sees his mistake at once and returns to dissect at the proper point. It may happen that during the opening of the deep fascia (especially if done quickly) not only the fascia but also the anterior wall of the sac, which lies immediately beneath it, is slit open. If the operator is not aware of the accident, he may dissect off only the anterior half of the wall, thinking that he has the entire sac before him. If he is sufficiently careful, however, and notes the injury, he can retrace his steps and without much difficulty find the right spot for continuance of the dissection on the outer side of the sac wall. The cleaner the dissection of the sac, i.e., the closer to the wall of the sac the operator keeps, by constantly dissecting between it and the covering fascia, the more satisfactory will be the course of the operation. It is remarkable with what perfect freedom from hemorrhage and pain the operation may be performed. The operator who lacks sufficient knowledge concerning the exact position and surroundings of the sac, and resects it together with all the attached tissues so as to be certain to have the sac in the excised

portion, will be greatly annoyed by hemorrhage, and his patient will suffer much pain.

Even the experienced operator may fail occasionally in extirpating the sac in one piece and may remove it in several portions. This may be considered as practically a failure, **as small particles of the mucous membrane are retained,** which could cause continuance of the discharge or, still more unpleasant for the patient, lead to formation of a fistula. The causes of such a disappointing result may be an exceptionally profuse hemorrhage, preventing accurate dissection, tearing of the sac during operation, or, finally, the partial destruction of the anterior wall of the sac, the dacryocystitis having produced a rupture into the surrounding tissue without having gone so far as perforation of the skin.

The beginner finds more difficulty in the resection of the lateral than of the median wall, since in removing the latter he need only keep close to the bone. It is also quite a common error to sever the sac some distance below the apex, leaving this portion behind, since the top is closely adherent to the fascia covering it and must, therefore, be removed with the sharp edge of the scissors. The importance of inspecting the wound carefully after an entire removal of the sac, to note whether or not the bone is healthy, is especially great in instances in which a part of the sac has been left behind. Curetting blindly with the sharp spoon is not only a crude procedure, but entirely without value.

If parts of the sac have been left behind, the wound should be well packed, the best material being tannin-iodoform gauze, and further operation deferred until the bleeding has been checked completely. The wound is then held widely open with the speculum, and a careful examination made. In most instances it will not be difficult to see the parts of the wall which have been left behind and these must be grasped with forceps and carefully separated from underlying fascia and bone. It is only by removing all the remaining mucous tissue that a cure and healing by first intention can be expected.

If the wound is sutured over retained particles of mucous membrane, primary union is prevented. Within a short time the wound is distended by secretion, and the sutures rupture, or must be removed to allow escape of the retained secretion, otherwise **persistent suppuration** will be the inevitable result. In the event of suppuration the wound must be loosely packed with iodoform-gauze and washed with weak bichlorid solution or a 6 per cent. solution of hydrogen peroxid.

To at once curette the wound is an error, as it is impossible during the period of granulation to recognize all the details of the wound. Even though the sharp curette is thoroughly employed, the discharge will not cease. The mucous membrane attached to the bone may be removed by the operator, but that of the lateral wall, not having firm tissues beneath it, always escapes the sharp instrument.

The skillful operator will often have occasion to dissect the entire lateral wall and top of the lachrymal sac of patients who were treated without success by repeated curettings, and will have no difficulty in effecting an instantaneous cure by primary union.

Under such circumstances the preparation for extirpation is more difficult than in those cases in which the tissues are still untouched. Even in such cases it should be the aim of the operator to remove layer after layer, at least as far as possible in the scar-tissue, instead of following the usual practice of cutting down in the first incision to the anterior lachrymal crest.

The anemia produced by the cocain-adrenalin infiltration in the dense scar-tissue is here of decided advantage, as it permits the operator to see every step of the operation very clearly. The bluish color of the mucosa readily differentiates it from the white of the scar-tissue, and in most instances it can be peeled off very easily. This is then followed by a close scrutiny of the wound to be assured that all the lining has been removed, and then, as in a completely performed excision of the lachrymal sac, the wound is closed by sutures.

The operation becomes still much more difficult, if either after attempted extirpation or after dacryocystitis a **fistula** has developed. In such cases one has to perform a long incision (2 cm.) so that the fossa may be conveniently reached. The fistula must be completely excised. The incision, which at first is only through the skin, is at once deepened to the crest after the wound-edges have been dissected up and the wound well stretched with the speculum. The entire fossa is now cleaned out, thus excising all of the exposed scar-tissue. Very often the lateral fascial boundary can be found, so that after completing the operation there is presented the usual picture of the wound, i.e., the median border formed by the bone with its prominent crest and the lateral border by the fascia. Even in these cases it is not advisable to use the curette, but prove by close inspection of the wound that none of the mucous membrane has been forgotten. Suturing the wound is unfortunately often impossible, as the skin,

particularly if several attacks of dacryocystitis have preceded the operation, is easily torn. By packing the wound loosely, the rapid development of granulations is favored, and the cavity will soon fill up. Even after such an operation the scar may be remarkably insignificant. It is not uncommon for the repeated mistreatment of the tissues to result in a **ectropion** through shrinking of the scar. In these cases success in elevating the lid and retaining it permanently in its proper position has been achieved by sutures going obliquely through the wound-edges from without inward and from below upward.

If there is **great dilatation** of the lachrymal sac, which, acting like a tumor, pushes the skin forward, the operation cannot be performed by the rules laid down. The tissues covering the sac may be so atrophic that immediately after cutting through the skin the wall of the sac may be exposed. In other respects, however, the removal of the sac does not differ in the slightest from that of other tumors in this region. If proper care is taken not to injure the sac, successful operation is easy.

Tuberculous disease of the lachrymal sac, especially as seen in children, makes a radical operation difficult, as the wall of the sac is frequently destroyed through tuberculous infiltration which may implicate the bone. The diseased tissue must then be cut away, the diseased bone removed, and the wound packed with iodoform gauze and permitted to heal by granulation. Recurrence is common in this type of disease, and is usually accompanied by formation of fistulæ, which then make secondary operations necessary.

If an **acute dacryocystitis** exists, no incision is made unless perforation seems unavoidable. Otherwise we must be satisfied with applying moist antiseptic dressings and must wait patiently until the inflammation has completely disappeared, a matter of several weeks. Then the extirpation of the sac must take place to prevent the inflammation recurring. Formerly in such cases, the blood vessels being markedly dilated, profuse hemorrhage was the rule during the operation; this can now be completely avoided by the method of injection already given.

The Indications for the Resection of the Lachrymal Sac.—This operation is absolutely indicated: 1. In all cases of chronic blenorrhea of the lachrymal sac, which lead to marked thickening of its walls and eventually to its dilatation, to total obstruction of the naso-lachrymal duct, or to the formation of a fistula. 2. When an operation

(iridectomy, extraction of a cataract, etc.) is to be performed on the eye of the corresponding side. 3. When a purulent infiltration of the cornea has taken place (infected erosion, ulcus serpens, etc.). Cauterization of such an ulcer would not bring about the desired result as the discharge from the diseased sac would constantly flow over the denuded area and through its microörganism produce new infections. 4. In all cases coming to the dispensary, as these patients have not the time for a long course of treatments with sounds, and at best this method usually promises but indifferent results. Particularly is resection recommended if the treatment with probes has previously been carried out without substantial improvement.

The ultimate result of the resection-operation is very satisfactory. In a very short time the scar is hardly visible, the catarrh constantly associated with the blenorrhea soon disappears, and with it also the lachrymation, the latter probably through a nervous influence. Should the catarrh and epiphora persist after the operation, a careful examination should be made of the canaliculi, and if a slight amount of mucopurulent discharge can be squeezed from them, it is a sign that some mucous membrane has been left behind. If there is no discharge and the lachrymation continues for several months after the operation, the lower lachrymal gland must be resected.

CHAPTER III.

THE LACHRYMAL APPARATUS (Continued).

EXCISION OF THE PALPEBRAL LACHRYMAL GLAND.

This operation is performed in those occasional cases in which the watering of the eyes does not disappear spontaneously. When patients living at a distance require removal of the lachrymal sac, it is often best to simultaneously resect the lachrymal gland; this may possibly save the patient a second journey. Lachrymation from other causes may also indicate the operation.

The **palpebral portion** of the lachrymal gland is understood to indicate that lobule of gland-substance which surrounds the excretory ducts of the orbital lachrymal gland, at the point where they pass toward and through the superior conjunctival fornix. This so-called inferior lachrymal gland may be seen in many individuals by lifting or everting the upper lid at its outer part, while the patient is looking downward and inward; sometimes it bulges forward in the form of a small lobulated tumor. To reach the gland conveniently, **the lid must be everted twice.** This is done best by first everting the lid with the finger in the usual manner, then inserting an opened lock-forceps at the junction of the outer and middle thirds in such a manner that one blade is pushed beneath the lid into the conjunctival fornix, the other lies anteriorly on the tarsus. The lock is slowly closed and the lid everted the second time by turning the forceps slowly upward.

If the conjunctival sac has been well cocainized at the outset, **the resection,** carefully performed, is not painful. One-third c.c. of a 1 per cent. solution of cocain should be injected under the conjunctiva; the injection is best made into the tissues between the point of the forceps and the external canthus. The operation itself is not difficult, but it must be performed carefully if the gland is to be resected in one piece, and not cut away in a number of fragments.

The first step in the operation is to make an incision through the conjunctiva with a small pair of curved scissors; this should extend horizontally from the point of the forceps toward the external canthus for a distance of about 1 cm. The lobules, which may be numerous

and well developed, at other times few and small, protrude through the wound as soon as the connective-tissue membrane which encapsulates the lachrymal gland is opened. (The cocain-injection may obscure the outlines of the structures at this time.) **The next step** is to carefully dissect the conjunctiva loose both in an upward and downward direction, i.e., toward the tarsus and toward the ocular conjunctiva. Of considerable aid is the retraction of both portions of the conjunctiva by the assistant with a double tenaculum. The **lachrymal gland** will finally be seen as a small node in the center of the

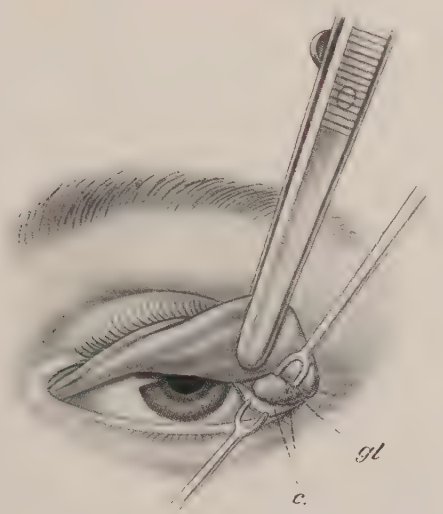

FIG. 9.—Extirpation of the lachrymal gland. The upper lid is turned upward twice—i.e., upon itself—and is maintained in this position by a lock pincette held by an assistant at the outer third of the lid. The conjunctiva (c) is freed on both sides of the gland. The wound is held open with double tenacula. In it is seen lying perfectly free the lower lachrymal gland (gl.), appearing as a small nodule.

wound (Fig. 9). The gland is now grasped with forceps and separated from the orbital lachrymal gland with cuts of the scissors, beginning at the nasal end. It is not necessary to dissect high up into the orbit, but it is important that the lobules are shelled out for their *entire length*, as only then can all the excretory ducts of the large gland be cut through. The amount of glandular substance removed during this is of no moment whatever. The white membrane laid bare in the floor of the wound is the **tarso-orbital fascia.** It must not be injured. It lies in front of the gland and does not interfere with its extirpation.

Its injury might have added unpleasant consequences on account of its **connection with the tendon of the levator palpebræ** and the possibility of **resultant ptosis.** Fastening of the forceps at the outer third of the lid, as ordered above, will prevent such occurrence, even if the dissection is carried too deep and the fascia cut into and injured. An injury to the outer skin or the external rectus muscle can be produced only by reckless cutting; this is clearly apparent if the position of the gland is considered. The hemorrhage during the operation is slight, although usually disturbing, and the assistant is kept busy sponging up the blood.

One catgut **suture,** bringing the wound together from above downward, suffices, and the **dressing** may be removed after twenty-four hours. **After the operation** the eye is usually ecchymotic for some days on account of the blood subsiding to the lower levels. Slight swelling of the upper lid produces some ptosis, but this disappears soon. **The result of the operation** is generally good, even though occasionally lachrymation is but little diminished. In one such case, even though the operation was performed according to every rule mentioned, weeping persisted to such a degree that it became necessary to **remove the orbital lachrymal gland itself.** This operation must be performed through an incision from the skin.

Dryness of the conjunctiva or the cornea need not be feared either after extirpation of the inferior or the entire lachrymal gland, as the glandular secretion of the normal conjunctiva is sufficient to prevent this. However, after extirpation of the lachrymal gland, an obstinate and long-lasting catarrh of the conjunctiva associated with thick mucoid discharge is occasionally to be seen.

LACHRYMAL PROBING.

Dilatation of the Canaliculus.—Before attempting to pass a Bowman's probe, the *lachrymal canaliculus* must be dilated. This is done with a **conical probe.** Its first position is vertical to the inferior lachrymal canaliculus (Fig. 10). Before placing it in this position the patient is asked to look up and the lower lid is pulled outward and slightly away from the bulb, thus making the lid tense. The lachrymal canaliculi at first pass for a short distance downward, then gradually upward and finally describe an almost right angle to empty into the lachrymal sac. To dilate the left canaliculus, the physician, sitting in front of his patient, employs his right hand. For the right canalic-

ulus the left hand is used, or the surgeon may stand behind the patient to dilate the latter, and work with the right hand.

After the point of the vertically applied conical probe has entered the first portion of the lachrymal canaliculus, the probe is depressed into a horizontal position and then pushed slowly forward, employing a slight twisting movement until the bone is reached (Fig. 11). When lightly drawing the probe to and fro does not cause retraction of the skin, we know that its point has passed through the canaliculus into the

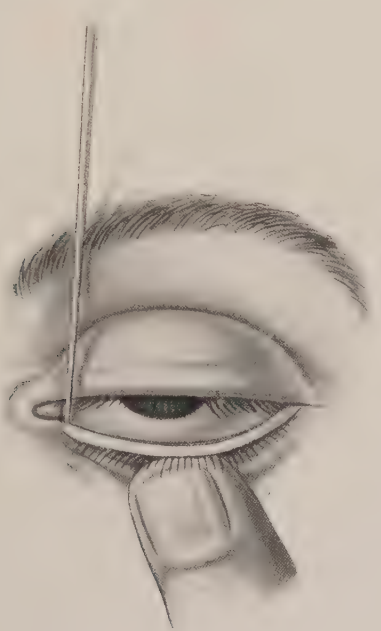

FIG. 10.—Introduction of the conical probe into the lower lachrymal canaliculus. The lid is pulled outward with one finger, and the lachrymal punctum thus turned slightly forward. The probe is inserted vertically.

lachrymal sac and has come in contact with its median wall. The operator must *be careful not to use force* in dilating the lachrymal canaliculus, as the point of the probe penetrates the wall easily, and a false passage is thus made that makes proper probing almost impossible. **Injury** of the lachrymal canaliculus or the wall of the lachrymal sac is also to be avoided, because during subsequent injection of cocain for purposes of anesthesia or during a cleansing of the sac with any antiseptic or astringent solution, the fluid diffuses itself through the

subcutaneous tissues, producing marked swelling of the structures in the neighborhood of the lachrymal sac, as well as of the lids.

Through the insertion of the conical probe, which increases in size gradually, the mouth of the lachrymal canaliculus is so far enlarged that every number of the blunt Bowman's probe enters easily. The **slitting of the lachrymal canaliculus** for the purpose of passing these probes is **not necessary,** and, therefore, not to be recommended. The canaliculus is a good guide for Bowman's probe and with its aid the sac is always easily entered. When the canaliculus has been slit open, it may become very difficult to find the beginning of the portion which has been left intact and which forms the point of entrance to the

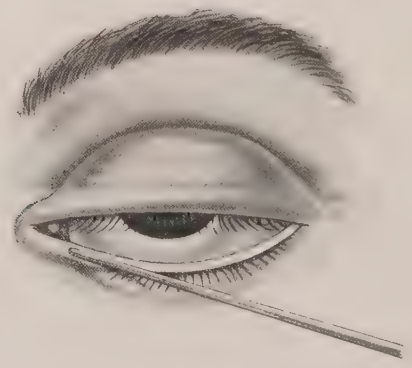

FIG. 11.—Second step in the dilatation of the lachrymal canaliculus with the conical probe. The probe is placed in the direction of the canaliculus, and is pushed forward with short twisting movements to the median wall of the sac.

lachrymal sac. Bitter experience has shown how fruitless in such cases such efforts may be, as occasionally the probe cannot be passed at all, the aperture after the slitting contracting secondarily through the formation of delicate scar tissue around it. There is usually no difficulty in passing a No. 5 probe through the intact lachrymal canaliculus.

Slitting the Canaliculus.—The canaliculus should be slit only if through **eversion of the inferior lachrymal punctum** the course of the tears has been diverted and they trickle down the cheek, or if an **ectropion** of the lower lid has begun to develop. Slitting the lower canaliculus converts it into a backwardly directed channel which communicates freely with the conjunctival sac; the tears are thus guided into their normal path and one of the main causes of ectropion is

removed. This operation is performed with a **Weber's knife,** which is inserted into the dilated canaliculus and pushed in until the probe point of the knife touches the bone. The cutting edge of the knife is directed upward and *slightly backward.* The finger pulls the lid outward, making it tense, and the knife, the probe point of which remains against the bone, is turned up, thus cutting the lateral part of the canaliculus. The hemorrhage is slight. To prevent healing together of the edges of the wound, they must be separated occasionally during the next few days with the conical probe, until the epithelium has grown over them.

Probing the Duct.—For purposes of probing we use **Bowman's probes,** Nos. 1 to 6. The point of the probe is placed vertically into the dilated lachrymal canaliculus, and, after it has passed the lachrymal punctum, its direction is changed to the horizontal, the skin of the lid being drawn outward at the same time. When the tip of the probe strikes the bone, the lid is released and the instrument at the same time returned to its vertical position. With a slight push forward the probe glides readily into the naso-lachrymal duct, provided there are no adhesions. The position of the probe in the upper part of the canal is easily recognized; if it is in the canal it will remain standing when the hand is taken away, it falls over if it is not in the canal. If the probe is in the canal for a certainty, and resistance is met with in pushing it forward, slight force may be used to push it through **stenoses and adhesions.**

If, however, we are not certain that the probe is in the canal, force should never be used. The wall of the lachrymal sac is easily perforated, and a **false passage** into the surrounding tissues established. It is to be particularly emphasized that the re-establishment of the probe in its vertical position and its gliding into the naso-lachrymal duct are especially difficult for the beginner. The probe is frequently pulled outward a little, its point leaves the bone and gets into a false direction. The conditions are especially difficult when the lachrymal sac is almost completely closed off by adhesions. If the beginner is not absolutely certain of his ground, it is hard to decide whether force may be attempted or whether a false passage is being made. If the probe has been inserted properly, its plate will be on a level with the eyebrows (Fig. 12) and it will have retained the slightly curved shape and position into which it has been brought. If the probe has entered a false passage, it can be recognized by the abnormal position in which it is found.

Ordinarily the rough ends of the perforation in the bone, through which the probe has been pushed, may also be felt.

Before commencing the probing, **the naso-lachrymal duct should be made anesthetic** with an injection of a 3 per cent. solution of cocain. The best instrument for this purpose is **Anel's syringe.** The most suitable model has a ring at each side; the second and third fingers are placed in these, while the thumb presses the piston down. The syringe-point is placed upright into the lachrymal canaliculus, is then changed to a horizontal direction and pushed into the lachrymal sac just as if it were a probe. In this position the fluid flows in with the slightest pressure. If the naso-lachrymal duct is patulous, a small amount of

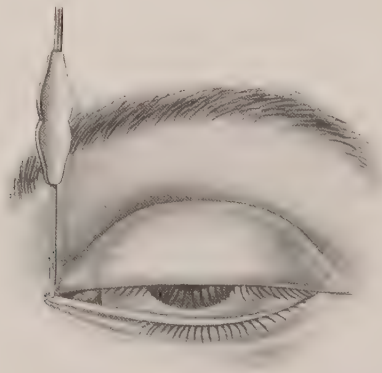

FIG. 12.—Bowman's probe is passed through the naso-lachrymal duct. The small plate of the probe is on a level with the eyebrow.

fluid will slowly run from the nose as the patient bends the head forward. If considerable resistance is felt, the fluid should not be forced out of the syringe under too great pressure, as it will either escape through the superior lachrymal canaliculus or it will be forced into the surrounding tissues from the lachrymal sac, setting up an unpleasant swelling of the lids which persists for several days, and for which the patient usually blames the physician. The douching of the lachrymal sac should never be performed with the *patient lying down*, especially if the fluid is a cocain or bichlorid solution; as, should the naso-lachrymal duct be patulous, the fluid will flow into the pharynx.

The probing is begun with No. 1, and is repeated every second or third day, the size of the probe being gradually increased until No. 5 is reached. It is well to remember that a thick probe may at times

pass by a fold easier than a thinner instrument. The passage of the probe may be considerably facilitated by the addition of a small amount of **adrenalin-solution** to the cocain. This contracts the blood-vessels in the wall of the duct, thus increasing its lumen and with it the space for the penetration of the instrument. The probes must be passed slowly and carefully, and slight injuries avoided, as these give rise to the formation of scar-tissue and through it to new stenoses. The instrument should be permitted to remain in the naso-lachrymal duct at least fifteen minutes each time. The probing must be continued until the fluid from Anel's syringe flows easily through the channel. Dilatation to probe No. 5 usually suffices. If the weeping continues it may be considered a proof, that in spite of the normal permeability of the lachrymal canaliculus, tear-conduction and possibly even tear-secretion is disturbed. **Tear-conduction** as is well known, is not dependent alone on the normal permeability of the nasal duct, but also, and perhaps to a greater degree, on the normal activity of the sac. In such cases it does not improve the patient to continue the ordinary probing or to employ the larger instruments.

It may be impossible to pass probes through the inferior lachrymal canaliculus in the manner described, owing to occlusion by scars following burns or injuries. The probes must then be passed through the **superior canaliculus.** Its course is analogous to that of the lower; first vertically upward, followed by a curve toward the sac. After dilating with the conical probe, cocain is injected into the sac with Anel's syringe. Bowman's probe is inserted in the direction of the naso-lachrymal duct, i.e., in vertical position.

The Passing of Probes in New-born Children.—We occasionally see cases in which the secretion is retained in the lachrymal sac, thus leading to considerable dilatation. This is the result of a congenital, but only epithelial, occlusion of the duct, and it is cured by one passage of a small probe. The operation is not more difficult in the new-born than in the adult, but it must be remembered that the distance between lachrymal point and nose is much less than in the adult, and therefore the probe does not penetrate as great a distance.

Indications for Probing.—If the constant dripping of tears makes the existence of a **duct-stenosis** probable, it is well for the physician to cocainize the conjunctiva, dilate the canaliculus with the conical probe and push Anel's syringe cautiously into the lachrymal sac to make sure of the diagnosis. If the naso-lachrymal duct is patulous,

very little pressure will carry the fluid through into the nose of the patient, as he holds his head forward. If the passage is narrow, the fluid will not flow through for a short time, and then only in small quantities, while the greater part escapes through the superior lachrymal canaliculus. The latter occurs if the lachrymal sac and the naso-larchymal duct are comlpetely occluded. Warning has already been given against using too much pressure, so as not to force the fluid into the surrounding tissues. After once making certain that the passage is narrow or completely occluded, the probes should be employed beginning with No. 2. If cocain cannot be injected before passing even the small probe, the attempt will be rather painful; at the second attempt, however, one can usually force a few drops of a 3 per cent. solution through, thus making the treatment less painful. **The treatment is continued** until the cardinal symptom indicating stenosis, persistent weeping, has disappeared, or at least a **No. 5 probe passes easily.**

Chronic epiphora does not, however, always mean stenosis of the naso-lachrymal duct, nor does this condition always rest on a mechanical basis. It may be a reflex condition as the result of diseases of the conjunctiva, the lachrymal passages, the nose, etc.; in fact it may also depend upon central disturbances. These are circumstances which should always be considered in the treatment of the affection.

If a marked blenorrhea of the lachrymal sac exists, the examination, as before, is preceded **by testing the permeability of the lachrymal passages.** In nearly all the cases a stenosis will be found, and the treatment as above described must be instituted. Conservative measures (passing of probes and lavage) are only employed in those cases of blenorrhea, which are not yet too far advanced. If the walls of the sac are already markedly thickened, if the sac is already dilated or perforated after acute inflammation, conservative treatment is out of the question. The blenorrhea itself is treated with a $\frac{1}{4}$ per cent. silver solution, in preference to all other agents.

To avoid the inconvenience of having to pass Anel's syringe into the canal after the probe has been taken out, the operator may employ **hollow probes,** to which Anel's syringe can be fastened, while the probe lies in the naso-lachrymal duct. When such a probe is pulled out, the solution washes the duct most thoroughly. A **fistula** in the tissues about the sac forms a rare indication for the lavage of the sac. To determine whether the fistula is connected with the sac, a blue

douche solution should be used. If a tumor exists in this region, it may be necessary to pass probes to determine whether or not the sac is free.

Contraindications.—Probes must not be passed in acute inflammatory conditions. If the lachrymal-sac disease is associated with disease of the bone(tuberculosis), the passage of probes is contraindicated; in such cases extirpation of the diseased sac must be performed. As already mentioned, total stenosis of the naso-lachrymal duct is also an indication for extirpation of the sac.

CHAPTER IV.

TRICHIASIS.

Of the numerous operations employed for the relief of trichiasis, two typical methods will suffice in the greater number of cases, viz.: those of Anagnostakis and of Panas.

The Hotz-Anagnostakis method is preferable in the ordinary cases of trachoma. It gives the best cosmetic results. The skin is incised along the entire length of the lid, either with a scalpel or a

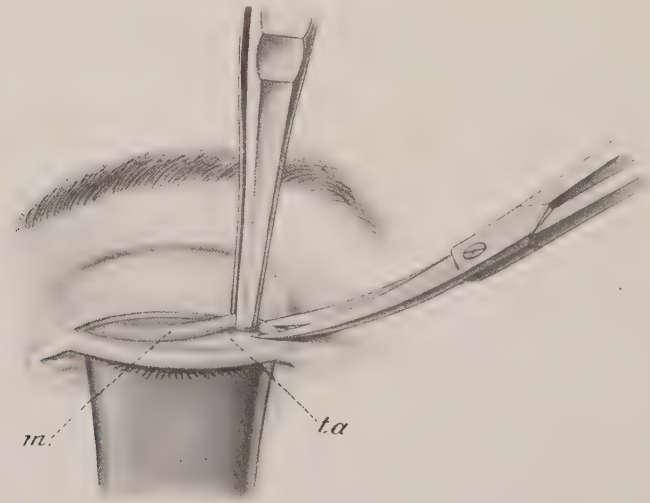

FIG. 13.—Excision of the fibres of the orbicularis muscle (m) covering the tarsus (ta). With forceps the fibres are grasped along their upper margin at the left angle of the incision; a small pair of curved scissors is applied close to the tarsus, and with short cuts the muscle is separated along the entire length of the lid.

lancet, 2 mm. above and parallel to the free margin. As with every incision into the lid, an ivory plate is placed beneath it, not only to protect the eyeball but also to provide a firm base, and by the compression exerted to assist in checking hemorrhage. Lying exposed in the wound are to be seen the reddish fibers of the orbicularis muscle, which run parallel to the edge of the lid. After the skin has been freed downward for a short distance, and upward to the upper border of the tarsus,

the fibers of the muscle are excised in a breadth of about 4 mm. For this purpose they are lifted up with a tissue-forceps at one end of the lid (Fig. 13), and severed all the way to the other end of the lid with one stroke of the scissors, applied flat. In this manner the entire tarsus is dissected free.

In most cases of trachoma, the tarsus is usually several millimeters thick, is of very firm texture and curved convexly forward. The beautiful striations produced by the Meibomian glands, seen in the tarsus of the cadaver, are not shown in the tarsus of a trachomatous

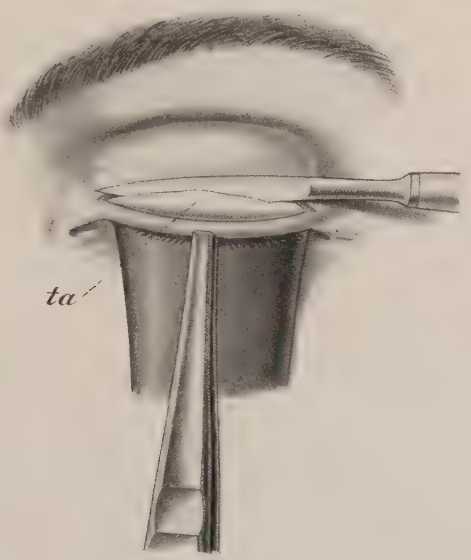

FIG. 14.—With the knife applied flat against the convex anterior surface of the thickened tarsus (ta), thin slices are cut. The upper border of the tarsus and the margin of the lid are not disturbed.

patient. In the latter the glands have disappeared for the most part, only some indistinct traces of them remaining. It is best to excise, or rather to diminish the thickness of this useless scar-tissue, which is the cause of the distortion of the lid. For this purpose a sharp scalpel is entered (Fig. 14) somewhat below the upper margin of the tarsus and parallel to its plane, and with a sawing movement downward thin slices are cut away. In a normal tarsus of the cadaver, this procedure cannot be demonstrated, as any attempt in this direction would immediately perforate the tarsus. On the other hand, in a trachomatous patient there is little danger of cutting through the thickened

tarsus. However, this perforation should be avoided. Only the uppermost part of the tarsus retains its original thickness; the margin of the lid also is left intact.

The Insertion of the Sutures.—The purpose of the sutures is to stretch and straighten the tarsus which has been bent backward by the disease. This is effected by fastening the lower margin of the skin-wound to the upper border of the tarsus. Because of the differ-

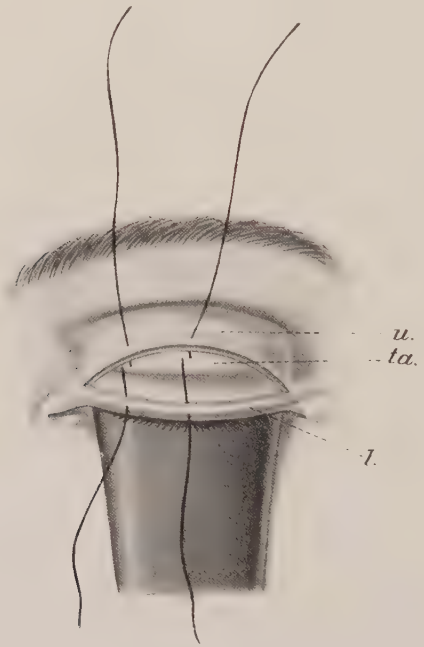

FIG. 15.—Two sutures are applied. They pass from above through the skin (u); then through the upper border of the tarsus (ta), in which they are firmly fastened; and lastly through the lower margin of the skin (l) above the cilia. Corresponding to the convex form of the upper tarsal border, the tarsal point of insertion of the outer suture is nearer the lower margin of the wound than that of the inner suture.

ence in the height of these two points, union is possible only if the lower border of the tarsus bends forward on itself and carries the cilia into the desired position. The sutures are therefore introduced in the following manner (Fig. 15):

The skin is first transfixed above at a point corresponding to the middle of the lid, and is then retracted somewhat by an assistant, so that the upper border of the tarsus is exposed. Next, the needle with the suture pierces the upper border of the tarsus. We penetrate in a

horizontal direction, introducing the needle from the wound-surface and bringing it out again immediately. In this manner perforation is prevented, which accident, however, is harmless. The assistant now permits the upper margin of the cutaneous wound to return to its normal position, and the lower border of the skin-wound is pierced at a point corresponding to the upper point of entrance. One suture is inserted in exactly the same manner on either side of the first, making three in all. Frequently four or five sutures are employed. The central suture is tied first. The two margins of the skin-wound are approximated with two tissue-forceps in the hands of the assistant. As the suture is tightened, the tarsus with the free border of the lid bends forward and somewhat upward (Fig. 16). It is better to induce slight over-correction at first, so that the margin of the lid is at a slight distance from the eyeball. The remaining sutures are tied with the same care, the ends being cut off at about the same length as in other skin-wounds.

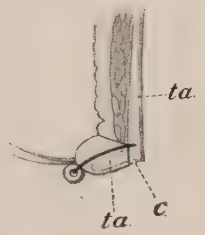

FIG. 16.—Sagittal section through the upper lid after completion of the operation. The margin of the lid, now placed vertically to the plane of the lid, is so adjusted to the tarsus (ta) that no part of it projects into the palpebral fissure; in fact, only a small portion of the wound-surface (the cut edge (c) of the tarsus) remains exposed.

A simple **dressing** is then applied and kept from adhering by the insertion of gutta-percha tissue covered with ointment. The other eye need not be bandaged. The dressing, as in every other lid-operation, should be changed on the following day. The sutures should be removed after four days.

Complications, etc.—If performed in the manner indicated the operation gives good results. As the edge of the lid is not injured, its normal outlines are preserved, which from a cosmetic standpoint is of great importance. The main advantages of the operation are that the pathologically heavy tarsus is rendered light by the excision, and the lid returns to its normal position without becoming shortened in the slightest. There are several disadvantages. The tarsus is crescentic in shape, being broadest in the middle of the lid and tapering off somewhat toward both angles. Therefore, the effect of the operation is better in the middle of the lid than at the ends. As it is not necessary to turn up the ends so far in order to attach the cutaneous wound-margin to the upper border of the tarsus, it is possible in certain rare cases that the trichiasis at the margin of the lid is not completely

overcome. However, by excising a small piece of skin, the lid can be slightly shortened and raised. At the same time a small incision may be made into the intermarginal border at a corresponding point, so that the sutures raise the cutaneous layer of the lid with its cilia, away from the eyeball. The small wound produced in the intermarginal border is allowed to undergo cicatrization.

Beyond this provisional incision no cut is made into the intermarginal border; in fact, a primary intermarginal incision would make the stretching of the tarsus impossible, for as soon as the anterior cutaneous layer of the lid is separated from the tarsus by such an incision, the rolling forward of the lower tarsal border can no longer be accomplished by the suture. Correction of the position of the tarsus is not intended in the secondary provisional intermarginal incision, but rather a displacement of the layer of skin containing the hair-roots, similar to that in v. Jaesche's operation. This latter operation alone would allow the thickened and heavy tarsus to retain its curvature toward the cornea, keeping up the irritation as before. Again, it must be remembered that the wound produced in the intermarginal border must heal gradually by cicatrization, which would interfere with the best cosmetic results. The lower suture must not be carried through the intermarginal border. It should be kept in front of the eyelashes; otherwise, it will eventually cut through the skin, and, by injuring the hair-roots, cause the cilia to fall out and possibly give rise to an ugly indentation in the edge of the lid.

The possibility of recurrence following this operation need not be feared, if the tarsus has been treated as above described. The thinning of the tarsus is an essential advantage, resembling in this respect, Snellen's method. If the tarsus is permitted to remain intact, the suture may be inadequate to straighten the rigid tarsus, and the slight resultant improvement may be destroyed by subsequent progressive contraction of the scar tissue.

Panas's method is a much more radical and serious operation, The eyeball is protected by an ivory plate and the incision through the skin of the upper lid is made as in the former operation. The muscle bundle of the orbicularis, however, is divided with the same stroke. The tarsus is freed as far as its upper margin. Excision of the muscle-bundles is not necessary in this operation. With a sharp scalpel a cut is now made through the tarsus immediately above and parallel to the margin of the lid, dividing the conjunctiva and extending

along the entire length of the lid. Thereby the free lid-margin is converted into a movable flap, which is connected with the surrounding tissues only at both lid-angles. This flap must be fastened to the exposed tarsus in such a manner that union is effected in a position with the eyelashes directed forward. To accomplish this, four **sutures** are inserted. The sutures are doubly armed and the needles should be thin and decidedly curved. First, we pierce with the one needle the upper margin of the wound in the tarsus *close to the cut*. It must be held parallel to the wound-margin, and is passed from the anterior surface and brought out again close to this point. Perforation of the

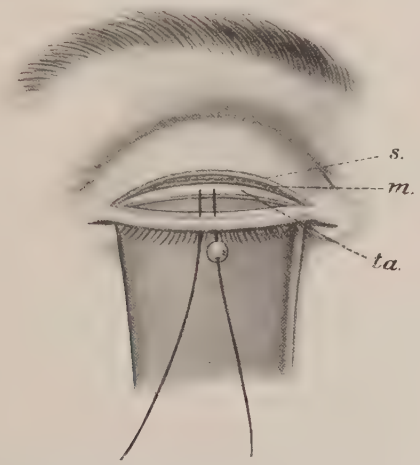

FIG. 17.—After cutting through the skin (s) and muscle (m), the tarsus (ta) and conjunctiva are incised, over an ivory plate placed between lid and bulb, along the entire length of the lid. The central suture has already been introduced. Above it is fastened to the tarsus near the edge of the tarsal wound. Both ends of the suture pass downward between tarsus and muscle and emerge in the intermarginal border behind the cilia. Over one end of the suture a glass bead is drawn.

thickened tarsus is easily avoided. Should it occur, it is of little importance, as the suture is drawn into the conjunctiva without injuring the cornea. In this manner the suture is fixed to the upper part of the tarsus, and both ends pass between the muscle and tarsus of the free flap through the intermarginal border. The other sutures are introduced in a similar manner (Fig. 17).

The assistant now turns the edge of the lid forward with forceps, thus bringing it perpendicular to the plane of the tarsus, and the operator ties the central suture, drawing a glass bead over it. He should be careful not to tie the suture so tightly that the glass bead will

exert pressure on the edge of the lid, as this might lead to circumscribed necrosis and subsequent loss of eyelashes. It suffices to tighten the knot just sufficiently to allow firm attachment of the flap. The other sutures are treated in exactly the same manner. The ends of the sutures are cut off short. The cutaneous wound must then be closed with several sutures, and an ointment-dressing applied to the operated eye. The sutures may be removed as early as the fourth to fifth day.

If the sutures are not firmly attached to the upper part of the tarsus, the operation will result in an unsightly disfigurement; if fastened at too high a point, the free edge of the lid is pulled up above the margin of the tarsal wound, and the tarsus projects free into the palpebral fissure. The wound-surface must then heal by granulation, which requires a long time, and terminates finally in the formation of a scar. As this rough cicatrix is directed toward the cornea, owing to the pathological curve of the tarsus, irritation of the cornea follows. If the sutures have been properly inserted, the flap fits in accurately and without any disfigurement. *The possibility of recurrence is absolutely excluded by this method of operation.*

There are several **disadvantages** which must not be under-rated. The base, from which the flap derives its nourishment, is small in proportion to the length of the flap, and is, therefore, in danger of undergoing necrosis. Should this unpleasant complication arise, the patient has not only been disfigured by the operation, but is probably even in worse condition than before, as now the upper lid is shorter by the necrosed piece, and a resultant lagophthalmos may be produced. Even if the operation passes off without complication, the upper lid has been shortened by the width of the flap, inasmuch as the flap has been turned out of the plane of the lid to one perpendicular to it. Short lids in patients seeking surgical aid must, therefore, be considered another contraindication to the operation, as in such cases lagophthalmos may be produced.

The lower lid may be operated on after the methods of Hotz and Panas in exactly the same manner as the upper lid. Because of the small size of the tarsus, however, Hotz's operation is less favored.

Other methods of Operation.—With the foregoing two operations all cases of total trichiasis, that is, in which the disease extends along the entire length of the lid, and which still have their cilia arranged in regular order, can be successfully overcome. The **method of Flarer,** resection of the layer containing the hair-roots, is not described because

it is always disfiguring. The **method of Jaesche-Arlt** consists in a displacement upward of the hair-root layer. Like all skin-transplantations on the lid-margin, it sets up fresh irritation of the cornea because of the fine lanugo hairs, always present in the skin.

FIG. 18.—Position of the intermarginal and skin-incisions. (a). Base of the skin-flap containing the eyelashes. (b). Base of the upper skin-flap.

Special consideration must be made of cases in which the trichiasis is confined to only one end of the lid, and also of those in which the cilia are no longer arranged in a regular row, but stand out from the lid-margin in various directions, occasionally projecting obliquely backward from the posterior edge of the lid.

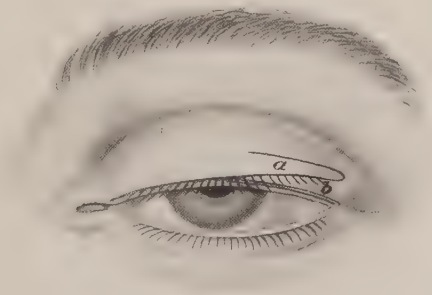

FIG. 19.—The flaps interchanged.

Partial trichiasis, at either end of the lid near the canthus, is best treated by the **operation of Spencer Watson.** This may be briefly described as follows (Fig. 18 and 19): An incision extending along the entire length of the area affected is made in the intermarginal border. The skin of the lid is incised 2 mm. distant from and parallel

to the margin of the lid. By turning downward the lid-margin, the cutaneous incision is made to terminate at the canthus and join the intermarginal incision. In this way the cilia are contained in a flap, the base of which lies on the side away from the canthus. By a second skin-incision, 2 mm. above and parallel to the previous one, another flap can be marked out, the base of which lies on the side of the canthus. By undermining, the flaps are made movable so as to be exchanged in such a way that the flap with the lashes comes above, while the upper skin-flap is placed at the margin of the lid. The flaps are held in the new positions by sutures passing through their angles, and within a few days permanent union takes place.

If this method were applied to cases extending the whole length of the lid, the flaps would have too small bases as compared to their length, and in consequence could very easily break down. Like all skin-transplantations, the operation has the drawback of inducing renewed symptoms of irritation from the fine hairs in the skin-flap. However, as the flaps in the cases just spoken of lie to one side of the cornea, this is not a very important disturbing factor.

When the regularity of the arrangement of the cilia is gone, a condition which exists in the more severe cases of trichiasis, and is often associated with corneal complications, a **plastic operation** must be resorted to. This is performed in the following manner: An incision is made along the intermarginal border, and the skin, together with the cilia, is dissected away from the tarsus to about its upper border. As the skin is usually rather short, there is some retraction at once. By means of a few fine silk sutures the skin-edge is attached to the tarsus, a few mm. above the margin of the lid. The wound-surface produced in this manner is then covered with a flap obtained from the mucous membrane of the lower lip. After everting and cocainizing the latter, a flap of the size and shape of the defect in the lid is marked out and quickly separated from the underlying structures. It is then placed upon a pad saturated with warm normal salt solution with its mucous surface downward, and a pair of scissors applied flat to the surface, is used to free it of all adhering shreds of fat, so that only the delicate mucous membrane remains. This flap is then placed upon the defect in the lid with its wound-surface down, and its edges are brought into exact coaptation. Sutures are not necessary and not even to be recommended. The operated eye is then bandaged, and a piece of gutta-percha tissue covered with ointment is applied over the

upper lid to prevent the dressing from sticking. The flap soon adheres and heals firmly and in four to five days the dressing can be left off.

The results of the operation as regards the trichiasis leave nothing to be desired, but from a cosmetic standpoint the operation is not a success, as the conspicuous contrast between the white flap and the surrounding skin is always in evidence. In these severe cases, however, cosmetic appearance is not considered, as the danger of grave ocular complications makes reliable operative interference absolutely compulsory. Skin from the arm must not be used because of the foregoing reasons. We have repeatedly been compelled to excise such a transplanted flap from individuals in whom a plastic lid-operation for trichiasis had been performed in other clinics, because the fine hairs of the flap greatly irritated the eye. In such instances the skin-flap should be replaced with mucous membrane. The patient suffers more from the fine hairs of a skin-flap than from misdirected eyelashes; the latter he can at least see sufficiently well to pull out regularly himself with forceps, while the fine hairs of the skin are almost invisible.

In trichiasis affecting **individual lashes** the best mode of treatment is **electrolytic epilation.** At this is a rather painful procedure the lid must be thoroughly cocainized. The point of a Pravaz syringe is inserted into the skin near the margin of the lid and pushed forward so that the point to be treated becomes completely white or anemic during the injection (**infiltration-anesthesia**). The epilating needle, corresponding to the negative pole of the battery (the other pole, attached to a moistened flat electrode is placed over the forehead) is then inserted close to the cilia and pushed into the sheath of the hair-bulb; if the right spot is chosen, this can be done without difficulty. If a current from one-half to one milliampere strong, is permitted to act for 30 seconds, fine vesicles will be seen to rise from the hair-bulb, and the hair can then be extracted with ease by the use of the **cilia-forceps.** It is of advantage to employ a magnifying lens during the introduction of the needle, so the exact point of exit of the hair may be more readily observed. The epilating process must be performed in several sittings, as occasionally cilia, which have not been destroyed, grow again and cause fresh irritation.

CHAPTER V.

ECTROPION.

SPASTIC ECTROPION.

The clinical picture of spastic ectropion is well-known, as the condition is frequently seen, especially in children with scrofulous inflammation of the conjunctiva. The lid appears as though replaced by a tense, red mass—the swollen, edematous, infiltrated conjunctiva. These cases are easily relieved by **Snellen's suture** (Fig. 20). The thread used has to be double-armed by long, flat, strong needles. One

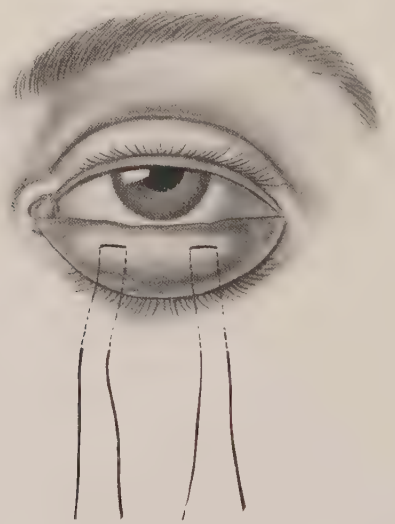

FIG. 20.—At the highest point of the inverted lid lies a suture 3 mm. long, the ends of which are passed under the skin to the lower border of the orbit.

needle is inserted through the conjunctiva at the junction of the inner and middle third of the highest point of the ectropion, i.e., usually at the convex cartilage margin, and carried under the skin downward until it is somewhat below the lower orbital margin where it is passed out. A second stitch is made in the same manner with the other end of the suture, 3 mm. to one side of it. By this procedure, a loop

is formed which overlies the palpebral conjunctiva in the place where the ectropion is most prominent, while below the two ends of the suture hang free through the skin. A similar loop is placed at the junction of the middle and outer thirds. Both ends of each suture are now tied over a small pad of iodoform gauze and tightened so as to bring the lid back to its normal position. The loops exert their action on the highest point of the ected afflid (Fig. 21), which is drawn down and brought back again to its proper position.

The same suture may be employed in the treatment of **spastic**

FIG. 21.—Vertical section through the inverted lower lid with the suture inserted. The tarsus has been bent forward during the closing of the skin-wound. The eyelashes are directed forward and slightly upward.

ectropion of the upper lid, the threads being drawn through the skin slightly above the upper orbital margin.

The stitches are allowed to remain in position for at least three or four days, but may be left longer should the case demand it. We must wait, however, until the edematous infiltration of the conjunctiva has disappeared, as the swelling tends to push the lid away from the eyeball. Spastic ectropion is most common in children with scrofulous conjunctival inflammation and catarrhal secretion, in whom the employment of a dressing would be an injury rather than a benefit. It is sufficient to cover the place, at which the knots lie, with a strip of plaster, leaving the eyeball itself free.

SENILE ECTROPION.

An entirely different method of operation must be performed in treating senile ectropion. In spastic ectropion an otherwise normal lid is brought into a false position by contraction of the orbicularis

muscle, whereas senile ectropion is produced through marked changes in the lid itself, which have originated in the course of a chronic inflammation. The lid has become elongated, the tarsus thickened and heavier, the skin flabby and not capable of offering resistance, and the lid, therefore, sunken downward. The employment of Snellen's sutures is of no value. Instead, we are compelled to **shorten the lid.**

The simplest method of operation, and in fact one of the first methods devised, is excision of a triangular piece from the whole thickness of the lid; the base of this triangle corresponding to the palpebral margin and of such length that the lid, after union of the wound by several silk sutures, is of the desired length, and lies neatly applied to the eye in its normal position. This simple operation had one great drawback; namely, a coloboma of the lid was frequently produced. The tarsus being soft and easily rent, the sutures readily cut through it, more particularly as the contraction of the orbicularis muscle constantly exerts traction on the two edges of the wound. The operation has, therefore, long since fallen into disuse, as either a large coloboma or at least an unsightly indentation of the lid-margin was the result.

Kuhnt tried to avoid this disadvantage by an operation, which consists in division of the lid at the intermarginal border and subsequent shortening by cutting out a triangular piece exclusively from the tarsus. The surplus fold of skin which remains as an ugly prominence, **Muller** attempts to remove by obliquely suturing it to the tarsus.

Another method is to shorten the lid by the **excision of a piece of skin,** which is taken from the region of the external canthus; in this manner an attempt is made to draw the lid outward and at the same time to elevate it somewhat. The procedure has the disadvantage that the relaxed skin will stretch again after a time, often allowing recurrence of the ectropion.

A combination of the methods of Kuhnt and Szymanowski, i.e., of the tarsal and cutaneous operation, yields perfect results, and should be employed exclusively for the treatment of senile ectropion.

The First Step.—The operation is begun by **splitting the lower lid in the intermarginal border.** This procedure is not easy in patients with senile ectropion, as the intermarginal border is usually indistinct, the posterior border of the lid perfectly rounded, and the conjunctiva thickened. It is desirable to make the incision with the lancet, with its point resting on the intermarginal border, while its

plane lies parallel to the surface of the lid. By so doing, we avoid perforation of the tarsus or wounding of the skin with the point of the lancet. A wound of the tarsus, when it lies in the region of the piece to be excised, has no particular significance; but if it lies to the side, the placing of the sutures in the tarsus may be made extremely difficult. The incision in the intermarginal border usually bleeds freely; it is, therefore, best when making the cut, to grasp the lid between the thumb on the skin side and index finger on the con-

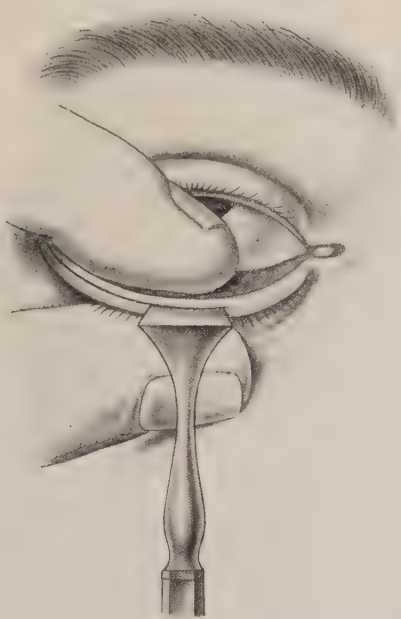

FIG. 22.—The lid is fixed between the thumb and index finger of the left hand. The lance pressed forward, its flat surface parallel to the surface of the lid, in the intermarginal border, at first to the center of the lid. The incision is next continued outward to the external canthus, as the line indicates.

junctival side (Fig. 22). The lid is thereby fixed and at the same time rendered comparatively free from blood, so that the incision may be made without annoying hemorrhage. Satisfactory anesthesia and anemia of the whole field may be produced with the cocain and adrenalin mixture described in an earlier chapter (p. 15). One has to inject the fluid into the thickened substance of the tarsus itself. Occasionally the solution spurts out of the openings of the Meibomian glands. A Pravaz syringe (1 cc.) is amply sufficient for this procedure.

The intermarginal incision is started slightly to the inner side of the middle of the lid and goes exactly to the external canthus. The greatest precaution must be observed not to wound the skin, as this injury may produce a coloboma of the lid. In order to prevent falling out of the eyelashes, it is also important that care be taken not to injure their roots. When the point of the lancet, which is held parallel to the lid-surface, enters the intermarginal border between the two layers of the lid, it sinks without much resistance between them. The lengthening of the incision to the external canthus by pushing the lancet forward laterally is not to be recommended, as there is always a risk of leaving the intermarginal border and either deviating forward with the cutting edge of the knife injuring the skin, or, backward, and penetrating the tarsus. It is decidedly safer, after an incision has been made, corresponding in length to the breadth of the lancet, to insert the point of the lancet in another place on the intermarginal border and bury it in the tissue; and, when necessary, even to insert it in a third place. Then one has simply to unite the separate incisions, if they have not already been connected while being made, by cutting through the separating fibers. In this manner the lid is divided without injuring the anterior or posterior layers.

If the operator wants to perform the intermarginal incision in one cut, a fine line must first be cautiously drawn with the point of the lancet and gradually deepened by making short cuts. It is almost impossible to draw this line if the intermarginal border cannot be distinctly seen, as is the case when the whole lid-margin is rounded by the ectropion. Therefore, we must be satisfied to keep behind the lashes near the posterior margin of the lid. The intermarginal incision is deepened until it is beneath the lower margin of the tarsus.

The Second Step is the Excision of a Triangular Piece from the Tarsus.—The length of this piece depends upon the degree of the ectropion. If too little is excised, the ectropion is not corrected; if too much, the two edges of the tarsal wound cannot be re-united by sutures. The operator must, therefore, carefully estimate in each case the necessary length of the area of excision. This is best done by raising a fold of the tarsus with two pairs of forceps, and determining exactly how much must be removed to allow the shortened lid to lie properly against the eyeball (Fig. 23). The forceps should be held in a vertical position, near the eye, and the fold (*f*) allowed to protrude forward. The length of the necessary excision may be only 5 mm., or even

double or more. The piece of the tarsus is taken exactly from the middle of the lid with a pair of short, straight scissors. A cut is first made from the inner corner through the tarsus, and the piece limited

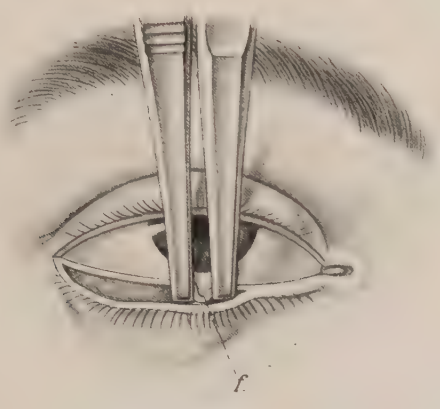

FIG. 23.—Two vertically-held forceps raise a fold (f) of the tarsus, so that it projects prominently forward. In this manner we determine how much must be excised from the tarsus so that it can subsequently be properly attached to the bulbus.

by cutting from the other side obliquely downward from the edge of the lid for a corresponding distance. The excision includes only the tarsus and the overlying conjunctiva. The conjunctiva under

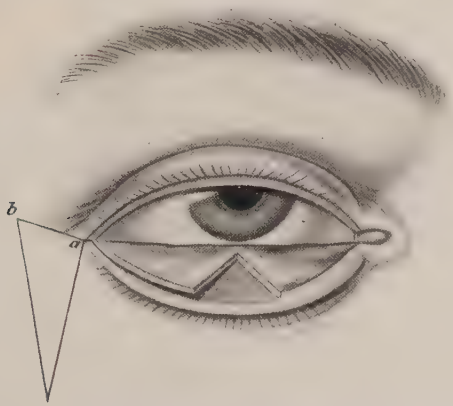

FIG. 24.—The measured part of the tarsus has been excised. The triangle is drawn in the region from which the skin is to be excised.

the tarsus must not be touched by the incision. The bleeding is controlled by the previous injection of adrenalin, but, if severe, must be checked by the application, for a short time, of two hemostatic forceps.

The third step consists in the **excision of a triangular piece of skin** from the region of the external canthus (Fig. 24).

The first incision is made with a scalpel or lancet from the canthus outward and is carried a trifle upward (*a b*). Its length equals, or exceeds somewhat, that of the piece excised from the tarsus.

The second incision is carried from the canthus perpendicularly from the first, i.e., downward and a trifle outward; this is easily twice as long as the first, so that its lower point lies vertically below the outer

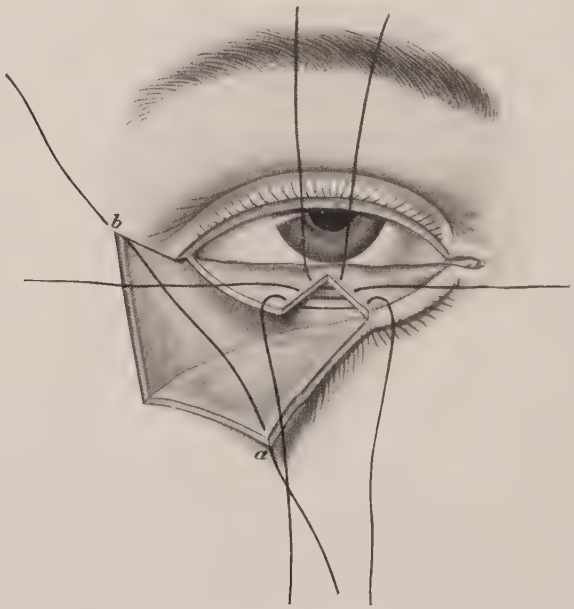

FIG. 25.—The triangular piece of skin is excised, the skin of the lid undermined and turned outward. The three sutures through the tarsus lie in their proper position. The principal fixation suture of the flap (a b) is likewise drawn through. The cilia are excised from the corresponding part.

end of the first incision. The ends of these two incisions are united by a third, and the piece of skin so isolated is excised. The skin of the lid is now completely undermined so that it may readily be drawn outward to cover the defect produced.

The fourth step consists in **uniting the open wounds** (Fig. 25). The first is the wound in the tarsus. Three sutures are employed so as to be certain of the permanent union. Strongly curved, fine needles with fine silk are used. The needle is inserted below, near the

point of the triangle, pushed from the conjunctival side through the tarsus out to the wound, and carried on the opposite edge from the wound side through tarsus and conjunctiva. The needle must not be passed through too close to the edge of the wound, because the tarsus, as has already been mentioned, is easily torn, and, if the sutures have once cut through, a second fixation is still more difficult. Both ends of this suture are turned upward. The second suture is passed through in a like manner. It is inserted through the middle of the tarsus, both ends should be placed horizontally. Special care must be employed to properly place the last suture, which insures exact union of the wound and must re-establish the margin of the lid. To accomplish this, the needles have to be put through the tarsus close to the edge. The threads are turned downward.

The pair of sutures turned upward are tied first. Nothing is more unpleasant for the operator than to be compelled to search for the threads belonging together by drawing one end to find its fellow; for this reason, detail description of the arrangement of the suture ends is dwelt on. As soon as the first suture is tied, and the edges of the wound in the tarsus approximated, the lid begins to roll inward and we must, therefore, in order not to work against this movement while tying the threads, hold them perpendicularly upward and avoid everything which might contribute to the separation of the lid from the eyeball. After tying, the ends of the suture are cut off close to the knot, then the second suture is tied and cut off close, and lastly the third.

On the cadaver the union of the two margins of the wound is more difficult than on the living, because the tarsus presents only as a thin membrane. In living patients, the wound-surfaces lie in much better apposition in consequence of the thickened tarsus presenting a broad surface. Usually the help of an assistant is not necessary in bringing the margins of the wound together.

If the two portions of the lid-margin do not fit, we can remove from the longer, with a pair of scissors, the small superficial projecting wedge.

The last step is the **covering of the triangular defect in the skin** by means of skin from the lid.

From that part of the skin of the lower lid which is to lie beyond the external canthus, we excise a small strip in order to remove the eyelashes. The first suture fixes the apex of the flap (*a*) (Fig. 26)

to the outer angle of the defect (*b*); the suture is immediately tied. As in every skin-suture, accurate approximation of the edges of the wound is absolutely necessary. Next follows a suture (*e*) along the upper margin of the flap and the skin to the outer side of the upper lid; in addition two skin-sutures, (*c*) and (*d*) are inserted. A suture between the tarsus and the skin of the lid-margin must be made if they are not already in good apposition. It occasionally occurs that a gaping fissure is found between them, and in order to produce primary union (otherwise, the lid-margin cannot be made to assume its normal appearance) a suture is placed between the two in the following manner: both needles of a doubly-armed suture are passed

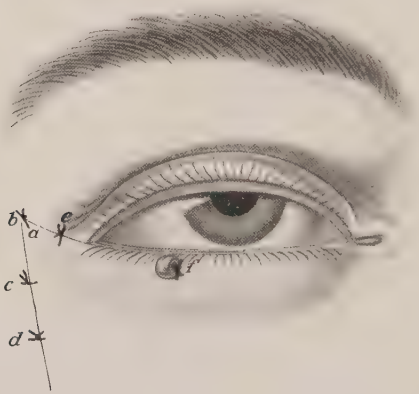

FIG. 26.—Appearance after the operation. The lower lid lies in its proper position; 4 (a, b, c, d, e) sutures sufficed for the fixation of the flap. One suture for the fixation of the skin to the tarsus is tied over a bead (f).

from the conjunctival side out, at a distance of 1 mm. from the margin of the lid and 2 mm. from each other, through the tarsus and forward through the skin and tied over a small pad of gauze or a bead. An ordinary suture would produce an unsightly indentation on the margin of the lid.

The lower lid is now shortened, lies closely against the eyeball and is at the same time slightly elevated.

Great care must be taken in applying **the dressing.** In order that no space exists between the flap and the underlying structures, it must be held down by a slight pressure-bandage. It is of the utmost importance that both eyes should be bandaged for four days. If the eyes are allowed to move, the knots in the tarsus greatly endanger the

cornea by the constantly rubbing against this sensitive structure. If both eyes are closed, the cornea rotates upward and lies behind the upper lid and is not in contact with the knots. The orbicularis muscle is kept quiet by the bilateral dressing, which also aids in the prompt healing of the wound. After the operation, a small amount of iodoform ointment is placed in the conjunctival sac. The bandage should be carefully lifted on the day following the operation to see that the cornea is not eroded. After four days the sutures may be removed from the tarsus, and a day later from the skin. Should one or more of the sutures in the tarsal wound tear out prematurely, the tear must be allowed to heal by granulation. Beyond delay in the course of healing, this occurrence has no significance.

As already mentioned, the result of the operation is always brilliant if the excised piece has been of a sufficient size, and the resultant scar is scarcely visible. The existence of a corneal ulcer does not contraindicate the operation; on the contrary, it can readily be seen how healing of such an ulcer might be effected without any further treatment than replacing the protecting lid in its proper position.

On account of the softness of the tissues, the suture in the tarsus may cut through at once, especially if there has been too much excision and the tissues markedly stretched. For this reason, as has already been mentioned, the needle must not be passed too close to the margin of the wound, but kept away sufficiently to allow the suture to have proper support. The greatest advantage of this method of operation lies in the fact that even in the cases in which the sutures in the tarsus cut through, the danger of a coloboma does not exist, as the anterior plate of the lid, the skin, remains uninjured. For this reason alone care must be taken not to injure the skin in making the intermarginal incision. As the skin itself is frequently highly friable and atrophic, the skin-suture may also cause trouble.

In excising the triangular skin-flap, the upper incision must not be carried straight upward, as Szymanowski, for other reasons, has advised, but only with a slight inclination upward. Otherwise, the skin of the lower lid will be drawn too far over the tarsus, and the union made much more difficult. If the pressure-dressing is properly applied, any stasis of secretion is prevented, and the attendant undesirable consequence, such as rupture of the skin-sutures and their necessary removal, is avoided.

I have recently seen a **rare accident** occurring after an ectropion

operation. The lid was first in faultless position, and I was not a little astonished to find, the day afterward, the lower lid again presenting a marked ectropion. The operation appeared to have been a failure, but the cause of the new ectropion was soon recognized. The skin of the lower lid, which had been stretched outward, exerted its greatest tension in the region of the lower margin of the tarsus; this was pressed against the bulb and the free margin of the lid was turned outward. The reposition of the under lid into its proper position did not improve the result, and only after applying a Snellen's suture, full recovery followed.

In cases of **bilateral ectropion** both eyes should be operated on at the same time, as in all cases both eyes must be bandaged after the operation; this spares the patient the prolonged closure of the eyes.

If the ectropion is not far advanced, the ordinary Kuhnt's method of operation, with possibly Müller's modification, will be sufficient. In such cases the intermarginal incision is made from the middle outward toward the canthus; the corresponding piece is excised from the tarsus; the tarsal sutures are made as above described; and the skin is attached to the tarsus by several sutures, which should be inserted obliquely, to avoid the formation of one large fold of skin; instead the superfluous skin is divided into several small folds, which later become entirely invisible.

PARALYTIC ECTROPION.

For correction of this deformity, resort must be had to the operation of tarsorrhaphy, which is described on page 65.

CICATRICIAL ECTROPION.

As a typical method for cicatricial ectropion does not exist, the delineation of the operative procedure is incomparably more difficult than those from the other forms of ectropion, and a detailed description is essential.

In general, the following stages may be considered as necessary: The first step is to divide the cicatrix which is holding the lid in an abnormal position. An **incision** is made with a scalpel, parallel to and usually quite close to the margin of the lid, throughout the whole length and depth of the scar, so that the lid, entirely free and movable, can be brought back to its normal position. As the cicatrix often extends to the bone, after caries and deeply penetrating corrosions, the orbital

margin, covered only with periosteum and cicatricial tissue, can become exposed.

The next step is to fix the lid in its proper position, and to cover the extensive area caused by the drawing away of the lid. This is manifestly the most important part of the operation, as otherwise, during the healing of the wound, the new cicatrix would draw the lid back again to its former position. This may be remedied by undermining and directly approximating its margins, or by a plastic operation.

The defect can be closed by **sutures** only if the wound is relatively small and the surrounding skin in a normal condition; for instance, if an ectropion has been produced on the external portion of the upper lid by a small scar following caries, and the lid-margin appears to be fixed to the bony orbital margin. After thorough separation of the scar and reposition of the lid in its normal position, the approximately horizontal wound may be converted into a vertical one by sufficiently undermining the surrounding skin and making traction on the middle of the upper and lower edges of the incision with two blunt hooks. Then by **horizontal sutures** the incision may be drawn into a *vertical* line.

By approximation in a slanting direction, that is, vertical to the earlier direction of contraction of the scar, the upper lid is placed correspondingly deeper, and in slight cases actually remains permanently in its normal position. Such approximation is only possible when the scar is small, so that the incision can be a short one, and when the surrounding skin is in a normal state. But it is impracticable in such conditions as the cicatricial changes following corrosives or lupus, which have so affected the skin as to make it unyielding.

It is manifestly wrong to do the operation before the caries had been cured. If a discharging fistula exists, the diseased bone has to be laid bare first through an incision and curetted; eventually, the sequestrum is removed. To protect the cornea from the danger of a subsequent ectropion, a tarsorrhaphy is made. In this operation, by fixation of the upper lid to the lower, the eversion of the upper lid is prevented. Then the diseased process is allowed to run its course and, not until it has completely healed, is the operation of dividing the scar and obliquely suturing the wound performed.

The cases in which suturing suffices for the repair are quite few; usually one has to cover the defect after separation of the cicatrix

with a skin-flap by a plastic operation. In opposition to many operators we believe that it is better to use, whenever possible, flaps without pedicles. Leaving out of the question the fact that in the greater number of cases of cicatricial ectropion (corrosion, lupus), pedunculated flaps from the surrounding skin cannot be taken (the skin itself being also contracted by the cicatrix), the cosmetic effect especially leads us to employ for covering the defect delicate flaps without pedicles. Pedunculated flaps project from the surrounding skin as thick irregular elevations and produce a marked disfigurement, whereas the extremely thin non-pedunculated flaps apply themselves smoothly against the denuded tissue and after some time present the same folds as the healthy lid and are differentiated from their surroundings only by their somewhat lighter color. The claim that non-pedunculated flaps constantly contract so much as to destroy completely the results of the operation is not true. We have formed new upper and lower lids by means of non-pedunculated flaps, and they are still, after some years, in a faultless position. The employment of the surrounding skin was absolutely impossible in consequence of a marked cicatricial contraction following corrosion with vitriol.

The results depend entirely on the manner of procedure in transplanting these flaps. The first condition necessary is a marked overcorrection of the defect. In the severe cases, which is the only type considered here, the whole upper and lower lids are found turned outward and usually lying in the region of the orbital margin, the upper lid closely adherent to the eyebrow. Occasionally the margin of the lid is relatively well preserved. The first step in the operation consists (as already stated) in the division of the scar and the releasing of the lid; an incision is, therefore, made with a scalpel, along the whole length of the scar, i.e., of the lids. On the upper lid it is often difficult to keep within the narrow zone between the eyebrow and margin of the lid; so far up has the lid been drawn from its normal position. If no lid-margin is present, the incision is made, if possible, at a distance of 2 mm. from the margin of the conjunctiva. After the scar is completely divided or, if the condition demands, excised, the lid, which is now freely movable, is drawn well over the other lid—the upper down over lower, or the lower well up over the upper. Three strong sutures are now passed through the margin of the freed lid and are fastened, either on the cheek (if the upper lid) or on the forehead (if the lower lid); both suture-ends must be passed through

the skin and tied over a small pad of iodoform gauze; if this is done, the defect will be covered by a flap, which considerably exceeds in size the dimensions of the normal lid. The hemorrhage may be checked either by compression or by temporary clamping with hemostatic forceps. The latter may be twisted off after a short time. Ligature with catgut is only necessary for the larger vessels. The small vessels in the scars soon stop bleeding without assistance. The wound, produced in this manner, has naturally an irregular, obtuse, triangular appearance, its surface showing as a depression below the orbital margin and toward the side of the nose. It is now temporarily covered with a tampon saturated with warm normal salt-solution.

The skin-graft flaps are prepared from the inner side of the upper arm. In order to form an idea of the size and shape of the flap to be excised, a piece of gutta-percha tissue, corresponding to the wound in form and size, is employed. This is laid on the part from which the skin is to be excised. After thorough disinfection, the skin of the arm is well stretched in an oblique direction by the assistant. As the skin retracts considerably in an oblique direction after being loosened, the flaps must be made much broader in this direction and trifle longer than the size of the paper-pattern. The flap should not be wholly separated at once; first, an incision is made on one side with lateral prolongations from each end of this for a short distance. The flap is now ready to be dissected with the lancet. It should always be the aim to remove only the superficial epithelial layers and those in the form of a single flap, and for this, the lancet (keratome) serves better than any other knife. If the surface of the lancet is placed parallel and close to the skin, it is not difficult by a stroking motion to separate the superficial epithelial layers. This work always proceeds slowly, and requires the greatest attention on the part of the operator.

When a small strip has been freed, it is rolled outward with a pledget, from which the salt-solution has been well squeezed out, so that the further dissection can be continued at the adhering point. The flap is detached in such thin superficial sections, that bleeding only occurs from the apices of the cut papillæ, and appears in the form of small dots. Care must be taken not to buttonhole the skin, as the openings, although small at the outset, increase in size by retraction of the margin of the sections, and are undesirable because their margins roll up and later make the proper adaptation of the flap to the wound

impossible. On the other hand, by rapid and careless working in preparing the flap, one can cut too deep and the sections are then thick and heavy and retract too much. When a section of the wished-for size has been prepared, it is separated from the point at which it is still attached to the skin, and is covered at once with two pledgets saturated with warm salt-solution. Before transferring the flap, the denuded surface of the wound should be stroked with the edge of the lancet in different directions, in order that a small amount of blood and serum may exude to ensure rapid adhesion of the flap to the wound. We must manifestly guard against deep incisions, which through more extensive bleeding, will lift the flap off.

Now follows the most delicate part of the operation, namely: **The adaptation of the flap to the surface of the wound.** The flap, which until now has been spread out on the pledget, is placed with its wound-surface on the defect, at first as its shape and form seem to indicate. The middle of the flap is then pressed well against the raw surface, best by means of a pair of closed forceps, and the pressure continued until it conforms to the surface of the wound; especial care being taken not to allow hollow spaces to separate the various pits in the wound from the flap, more particularly at the inner angle. After this follows the exact adaptation of the margin of the flap to the margin of the wound. To properly spread out the flap, as its margins roll up in every instance, the latter must be drawn out with Carlsbad needles,* and applied to the margin of the wound so that not even the slightest interstice remains between the two. If the flap is somewhat too large and the margins project over the edges of the wound, it must be reduced to the proper length with a pair of scissors. This adaptation must, naturally, be made along the whole periphery of the flap. Sutures are not recommended. After completing the adaptation, the flap and its surroundings are covered with an oiled gutta-percha paper and covered loosely, but carefully, with sufficient dry gauze to cause slight compression. The gauze is held in position by two broad strips of adhesive plaster. The other eye is also included in the **bandaging,** in order to prevent all movements of the lid. An outer starch-bandage makes the dressing stiff within a short time. The operation is performed under general anesthesia. The wound on the arm need not be sutured; the skin regenerates within a short time from the islands of epithelium remaining between the papillæ.

*A kind of long hat pin, the end of which has the form of a small lancet.

On the second day after the operation the **dressing** is changed for the first time. It is always encouraging, when the bandage is taken off, to find the flap in the desired position and already adherent. As no wound-surface exists, there is naturally not the slightest secretion. The flap is usually quite white, but occasionally the upper epithelial layers are somewhat darker in color. Simply because of this, no necrosis of the flap need be feared. Within a few days the delicate normal young skin makes its appearance beneath. Two days later, the bandage is again renewed. The fixation-sutures have by this time usually cut through, and are now removed. The lid remains at first still in the same position, and the flap has, by this time, healed sufficiently, to prevent its being displaced during a change in the position of the lid. Gradually and slowly the lid returns to its normal position. As has already been stated, if the proper precaution and care have been taken, the terminal results in most cases will be excellent. The skin is gradually thrown into folds as is the normal skin of the lid, and is differentiated from its surroundings only by its paler color.

Should an ectropion exist on both lids, the upper lid should be operated on first, and some weeks later the lower lid may be corrected. If the flap does not become adherent, it is found to be of a greenish-black color at the first change of dressings, and separated by profuse secretion from the granulations underlying the wound. Nothing remains to be done in these cases but to wait until the cicatricial process is concluded; then the original condition returns, and the same operation may again be tried. But if the first operation is completed without error in technic, this undesirable occurrence will be met with only exceptionally.

The plastic operation with pedicled flaps is described elsewhere. (p. 115).

CHAPTER VI.

ENTROPION.

SPASTIC ENTROPION.

Gaillard's Suture.—Spastic entropion can readily be remedied by Gaillard's suture. It acts in a manner similar to Snellen's suture (Fig. 27). A long needle curved on the flat is introduced under the skin at the highest point of the inverted lid and carried downward to the lower border of the orbit, and the same process is repeated with

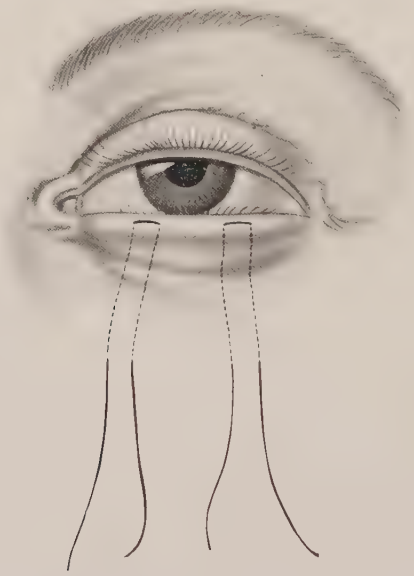

FIG. 27.—Position of the sutures. A suture 3 mm. long overlying the conjunctiva corresponding to the most marked anterior curvature. Under the skin the sutures extend to the region of the lower orbital margin.

the other end of the suture. Both ends of the suture are then tied over a small gauze compress. It is evident (Fig. 28) that by this suture the highest part of the inverted lid is drawn downward, a fold of the skin of the lower lid is tied off, and the edge of the lid is thereby everted from its position and turned away from the eyeball. Two sutures in all are introduced, one at the junction of the inner and

middle thirds, the other at the junction of the middle and outer thirds of the lid. The sutures are allowed to remain four or five days. The sutures are then removed by cutting them over the gauze compress, close to one of the points of entrance into the skin, and then drawing them through the wound. Occasionally a spastic entropion is produced under the bandage after cataract-operation. To restore the lid to its correct position, an attempt should first be made by means of a strip of plaster. Adhesive plaster is to be avoided, as it frequently produces an eczema. Zinc oxide plaster is much better, but often does not stick well in this position, as the skin is moistened by overflowing tears. In applying this plaster it is, therefore, important to dry the lid thoroughly first; then the strips of plaster, 1 cm. wide, are slightly warmed and applied, by pressure, at one end accurately to the edge of the lid. The other end of the strip, which should be about 2 cm. long, is drawn downward, pulling the eyelid with it into proper position and fastened firmly. Disappearance of the entropion may be effected more easily, if the patient's eye is left open without a bandage. For protection against mechanical injury, a Fuchs' lattice-frame should be applied, the wire-netting being covered with black cloth. The bandage may with safety be left off as early as the day after the operation, provided the wound is closed, so that there is no danger of the upper lid springing it open during the action of the palpebral reflex.

FIG. 28.—Vertical section through the everted lower lid with the sutures in position.

For **senile entropion** of the lower lid the best method consists in **excising horizontally an oval piece of the skin** from the lid. By picking up a fold of skin with the fingers, an approximation can first be made of the amount of excision necessary to bring the lid into the proper position. It is easy, then, with a scalpel or lancet to cut out on a plate, placed between bulb and lid a corresponding piece of skin of oval form which should be about $\frac{3}{4}$ cm. wide at its middle diameter. The wound, the upper edge of which should correspond with the border of the lid, is then closed by several vertical sutures. The resulting scar is hardly visible.

Graefe's operation consists in the excision of a triangular piece from the skin of the lower lid (Fig. 29). The first incision runs parallel to the edge of the lid at a distance of 3 mm., and is 3 cm. long. From both ends (*bc*) of the middle third of this cut, the two other

incisions (*be* and *ce*) are made downward, which uniting, form with *bc* an equilateral triangle. The area of skin thus circumscribed is excised. The edges of the wound at *b* and *c* are slightly undermined. The first suture, which is now introduced, approximates the two lateral angles (*bc*) of the wound. The skin is, therefore, shortened and stretched horizontally, exactly at the lower border of the tarsus; for by this means the cartilage is pressed toward the eyeball, while the free border of the lid is simultaneously rotated anteriorly away from the globe. The rest of the wound is closed by two additional horizontal sutures.

Immediately after the operation the lid is in a state of marked ectro-

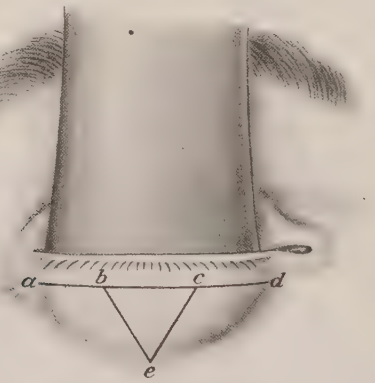

FIG. 29.—Horizontal incision (a d) through the skin 3 cm. long, parallel to and 3 mm. from the edge of the lid. From the middle centimeter (b c) two incisions (b e and c e), converging below. The circumscribed section of skin is excised. Suture of the two lateral sides (b e c) of the lateral triangle.

pion, and to such an extent, indeed, that its middle portion forms a protuberance. But this ugly position of the lid disappears within a few days, during which the skin relaxes a little, and the lid slips back into its normal position. If the first suture is too near the edge of the lid, the stretched skin presses the free border of the lid backward against the eyeball and thus increases the entropion. If the suture is too low, below the tarsus, it naturally has little of no influence on the position of the lid. It is, therefore, necessary to pay special attention to the first incision, parallel to the edge of the lid, so that it corresponds approximately with the lower border of the tarsus; i.e., 3 mm. from the edge of the lid. Occasionally after the operation, the lid has a tendency to slip back from the position of ectropion into that of entro-

pion; this may be prevented by means of a small gauze-compress, which should be applied along the lower border of the tarsus, in order to press it backward against the eyeball. In three or four days the sutures may be removed.

CANTHOPLASTY.

The purpose of canthoplasty is to lengthen the palpebral fissure.

The operation is performed by thrusting the blunt end of a moderate-sized, straight pair of scissors horizontally outward into the conjunctival sac beneath the canthus, which is then cut in a horizontal direction with one stroke of the scissors (Fig. 30). At the same time the other hand stretches the skin in the region of the canthus by

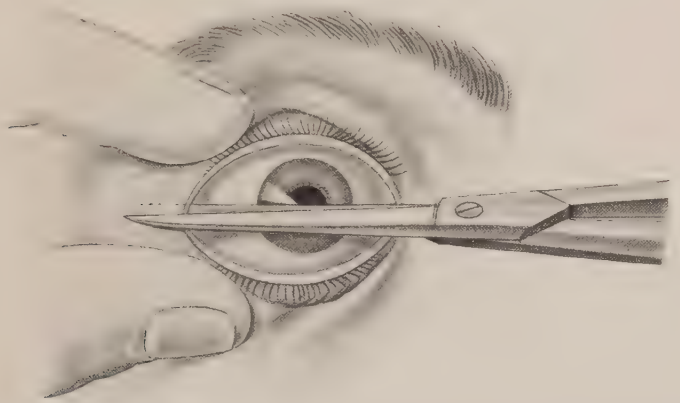

FIG. 30.—By means of two fingers the external canthus is separated and at the same time pushed slightly toward the nose. A pair of straight scissors is introduced horizontally with the blunt blade posterior.

means of the thumb and forefinger which are placed upon the outward halves of the upper and lower lids, separating them and drawing them toward the nose at the same time. If the cut of the scissors is to be made on the left eye with the right hand of the operator, the hand must be strongly flexed dorsally, in order to bring the scissors into the right position, or the operation must be performed from behind the patient. Bleeding is stopped by compression. In order to obtain a satisfactory result, an additional cut should be made with a small pair of scissors into the connective-tissue strands, which attach both lids to the edge of the orbit, so that the lids are freely movable and may readily be separated from each other.

If only a temporary widening (canthotomy) of the palpebral fissure is desired, no further operation is necessary. The wound closes in a short time, without leaving a permanent increase of the width of the palpebral fissure. Only the external horizontal scar remains as a visible sign of the operation.

In order to obtain a permanent result (canthoplasty), it is necessary to introduce sutures, which close the wound by uniting the conjunctiva with the skin. After making the incision, a rhomboidal wound is seen by drawing the lids apart (Fig. 31). If the conjunctiva be undermined a little, it can readily be drawn outward so

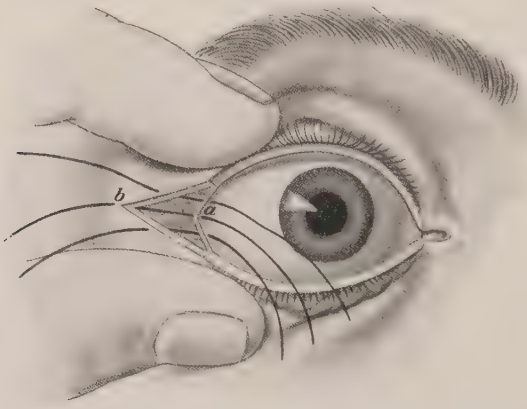

FIG. 31.—Form of the wound after incision. Position of the sutures for closure of the wound. The first suture unites the angle of the conjunctiva (a) with the angle of the cutaneous wound (b).

that the angle of the conjunctival wound (*a*) may be connected with the angle of the cutaneous wound (*b*). All that is then necessary is to introduce one suture above and below, to unite the lateral sides of the conjunctival and cutaneous wounds. To produce anesthesia, a 3 per cent. cocain-solution is dropped into the conjunctival sac, and during the second part of the operation a subcutaneous injection is made in the neighborhood of the external canthus with a half syringeful of a 1 per cent. cocain-solution.

Indications.—Canthoplasty is indicated if there is a marked secretion of the conjunctiva (blenorrhea, trachoma, etc.), with a relatively narrow palpebral fissure, making it difficult to carry out the treatment and to promote removal of the secretion. It is also performed in children with blepharospasm and edema of the lids, and is an effectual

operation for spastic entropion, as the cut of the scissors includes the point of insertion of the orbicularis muscle; namely, the external canthal ligament.

Finally, canthotomy is occasionally necessary to permit a larger field in operations on the eye or in entering the orbit. It is sometimes indicated in iridectomy, especially in pathologically enlarged eyes (buphthalmos); and in the operation of cataract upon patients whose eyelids twitch considerably. It is done to assist in performance of exenteratio orbitæ; also in ankyloblepharon, blepharophimosis, etc.

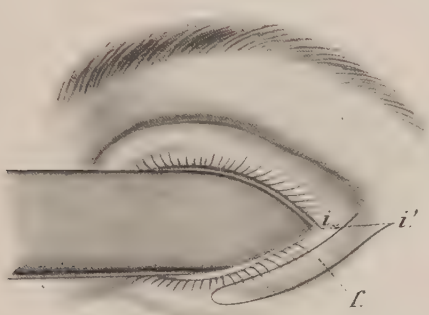

FIG. 32.—The lidplate is inserted outward under the canthus. The direction of the incision, to be made later through the canthus, is marked on the patient with ink-dots (i i'). A flap of skin (f) is cut out of the lower lid, the base corresponding to the outer half of the marked line.

Kuhnt's Method.—In trachoma, if the conjunctiva is markedly contracted it may be difficult or even impossible to unite the conjunctiva with the skin. The sutures tear out either immediately or shortly afterward, so that the wound closes up again and the palpebral fissure returns to its former small size. These are usually urgent cases, eyes in which trachoma has caused pronounced infiltration of the cornea that has resisted all treatment. Such cases are better for Kuhnt's modification of canthoplasty, which is performed as follows:

By means of a few India-ink dots the line of incision for the canthoplasty is first drawn, this line being a straight prolongation of the palpebral fissure from the external canthus to the outer border of the orbit. A Jaeger's ivory plate is then inserted under the outer commissure, and while stretching the skin a little upward and toward the temple, the operator cuts a flap of skin 2 mm. wide out of the

lower lid, as indicated in Fig. 32. The base of the flap is situated so that it shall be adherent to the upper edge of the wound after the incision for canthoplasty is made (Fig. 33). The length of the flap corresponds approximately to one-third the length of the lid, but must be cut a little longer, as the skin always retracts after it is detached. The orbicularis fibers, which appear in the lid after removal of the flap, are excised. The horizontal external incision is then made as in ordinary canthoplasty. The flap of skin mentioned above now hangs free from the upper edge of the wound, and is so placed that it remains several millimeters from the outer angle of the wound. By means of a scissors, all adhesions of the lids to the edge of the

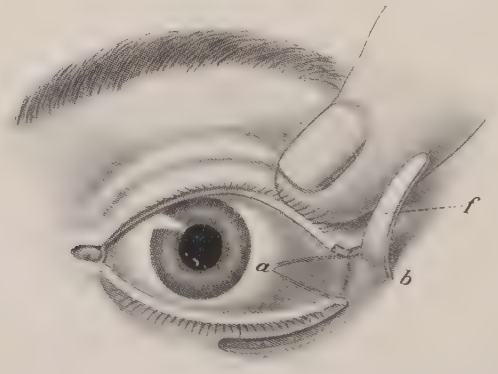

FIG. 33.—The flap (f) is separated, and has shortened somewhat by contraction of the tissue. The incision through the canthus is accomplished so that the same wound-angles in the skin (b) and conjunctiva (a) are produced as in Fig. 31. But here the angle (a) has receded towards the cornea, as a result of retraction of the contracted conjunctiva.

orbit, have to be thoroughly cut, so that the lids can be moved freely, and the bulbar conjunctiva is undermined to the boundary of the cornea. After arrest of hemorrhage the wounds are closed by sutures. Three sutures are sufficient for the wound on the lower lid, and a fourth fastens the temporal border of the lower lid obliquely outward near the outer angle of the wound. The cutaneous flap itself is laid in the wound, so that its apex is inserted either under the angle of the conjunctival wound, or is fixed to the latter with a suture (Fig. 34).

As there is usually an entropion of the lower lid the removal of a cutaneous flap also exerts a favorable influence on this anomaly of position. If the upper lid should need correction, the flap could be taken from it instead of the lower lid.

In severe cases of trachoma we have repeatedly observed a very

favorable influence of this operation upon the condition and further treatment of the disease. Certainly, from a cosmetic standpoint, the operation cannot be recommended, but in such severe cases the personal appearance no longer need be considered. By healing of the cutaneous flap, which occurs promptly, the palpebral fissure remains permanently and considerably widened. The sutures may be removed in a few days.

TARSORRHAPHY.

The object of tarsorrhaphy is to shorten the palpebral fissure. The operation is necessary, when, as a result of lagophthalmos, the eye is in danger of being injured. It is indicated in cases of facial

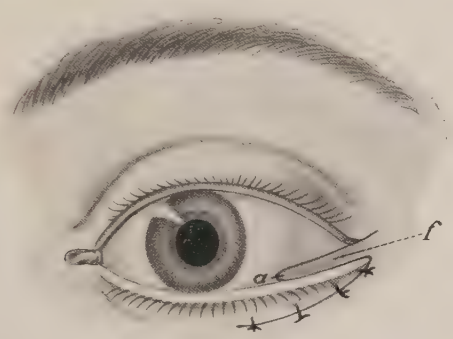

FIG. 34.—The wound on the lower lid is sutured, the flap of skin (f) being fitted into the angle of the conjunctival wound (a).

paralysis that will presumably exist a long time or will never recover, and in cases of marked exophthalmos resulting from Basedow's disease or from tumors. Naturally, the cosmetic result is never pleasing, but the operation is rendered necessary by existing circumstances, and is unavoidable.

The method of Fuchs is almost exclusively employed by us. The following is a description of **external tarsorrhaphy:** At the outset it must be clearly determined how much the palpebral fissure it to be shortened. This is best done by holding the two eyelids together, with the fingers placed at the external canthus, and shortening the palpebral fissure by advancing the fingers until the patient is able, completely or almost completely, to close the eye. At most, a few millimeters will be sufficient, but even in severe cases a distance of 8 mm. is never to be exceeded on account of the marked and very unsightly

asymmetry of the palpebral fissure that would thus be produced. In such a case we would be forced to do the same operation also at the internal canthus, of which mention will be made later.

At the desired point a *small vertical incision* is made through the skin of the upper and lower lids, not only to indicate how far the operation is to be conducted, but also to secure equal distances for both lids. A subcutaneous cocain-injection is made in the upper and lower lids, the point of the needle being directed towards the intermarginal border, in order to make the incision of this edge painless.

Then an *intermarginal incision* is made on the lower lid, beginning exactly at the external canthus, and extending to the indicated point.

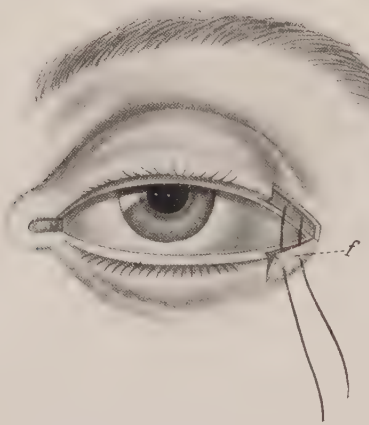

FIG. 35.—From the external part of the lower lid a flap of skin (f) is formed, and the cilia removed. From the skin of the upper lid a corresponding long strip is excised. The suture is already introduced: above near the edge of the lid, below near the base of the flap.

The eye is protected by the ivory plate. The incision is best made with a lancet, which should be held parallel to the surface of the lid, so that the point will perforate neither the skin not the tarsus posteriorly. While drawing the skin of the eyelid outward, the assistant presses the obliquely-held ivory plate forward, so that the eyelid is well stretched. By light pressure the operator himself holds the eyelid against the plate and places the point of the lancet upon the intermarginal border. If the lancet is sharp, it will readily penetrate between the two plates of the eyelid. At the same time a little undermining can be done.

A *vertical cutaneous incision* 3 mm. long is then made, beginning at the point marked on the border of the lid. In this way a *small*

cutaneous flap (Fig. 35 *f*) is formed from the lower lid, with the eyelashes still in position on the edge corresponding to the border of the lid. The roots of these lashes are then injured by means of a scissors applied flat against the raw side of the flap at the margin of the lid, so that the cilia fall out later.

The Upper Lid is Now Prepared. The same intermarginal incision is made as below, from the external canthus to the mark. Then a cutaneous incision is made in the upper lid, parallel to its border at a distance of about 2 mm. from it and of the same length as the intermarginal incision. The lancet undermines the bridge of skin thus formed, and two cuts with the scissors sever its connections externally and internally. In this way a raw surface is produced on the edge of

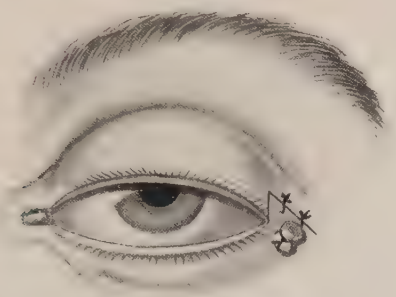

Fig. 36.—Appearance of the palpebral fissure after the tying of the sutures. Both ends of the first suture introduced are tied over a small gauze-compress.

the upper lid. The flap formed from the lower lid is now adjusted so that it covers this raw surface and unites with it. The tarsi are not injured in this operation. The tarsus of the lower lid slips in beneath that of the upper lid.

The fixing suture is made with a double-armed thread. Both needles are first passed through the upper lid near its border, proceeding from the conjunctival surface outward. The two perforations are about 2 mm. apart. A short piece of thread, therefore, lies on the conjunctival surface side of the upper lid. This is of no consequence as it does not come in contact with the cornea, which lies farther inward. Then each end of the thread is passed through the base of the flap on the lower lid from the raw surface outward to the cutaneous side, with about the same distance between the perforations as before (Fig. 36).

If both ends of the thread are then tied over a small compress of iodoform gauze, the base of the flap will be drawn to the edge of the upper lid, and the flap itself will lie over the raw surface of it. Several fine cutaneous sutures are then introduced to unite accurately the edges of the flap with those of the wound on the upper lid. A light dressing is applied over the eye. The stitches may be removed on the third day. As the interference has been slight, the other eye need not be bandaged.

The advantage of the operation is that a surface union of the lids is produced, and in this way a separation of the suture is avoided—an occurrence which is often encountered in other methods of operation. **The disadvantage** of this method lies in the sacrifice of a part of the normal cutaneous border of the lids. If at some future time it should be desirable to re-open the palpebral fissure, it is not difficult to free the upper and lower tarsal borders, as the tarsus has not been injured, and a few sutures will unite the edge of the cutaneous wound with this edge of the tarsus, but the border of the eyelid thus made would naturally have no cilia. Therefore, tarsorrhaphy is performed only in those cases, in which presumably no recovery is to be expected, e.g., in many cases of facial paralysis. The operation may be accompanied by unpleasant results, caused by an inequality in the length of the intermarginal incisions on the upper and lower lids. If, for example, a longer piece is excised from the upper lid than will be covered by the flap from the lower lid, the latter will, of necessity, be pulled obliquely upward and inward, producing in this way an ugly fold resembling an epicanthus. At the same time the cilia on the neighboring part of the lower lid may also assume an oblique direction, and in this way a trichiasis will be produced. Should this occur it would become necessary to destroy additional eyelashes by electrolytic depilation.

Indications.—Tarsorrhaphy is well suited, not only to cases of lagophthalmos caused by facial paralysis, but also when the condition is caused by congenital shortening of the eyelids; further, it serves to overcome paralytic ectropion, as it raises the ptosed eyelid. It is also recommended as a preventive of cicatricial ectropion in persistent carious fistula on the border of the orbit. Even though the operation in itself is disfiguring, it may still be indicated for cosmetic reasons in some rare cases, such as widening of the palpebral fissure after strabismus operations, or unilateral enlargement of the eyeball (uni-

lateral, high grade myopia) and its consequent widening of the palpebral fissure. Tarsorrhaphy is also performed occasionally as a preliminary to plastic operations.

Complete closure of the palpebral fissure is only undertaken in rare cases. For example, after an extensive corrosion, in which the skin of the upper and lower lid has been partially destroyed, and the production of a cicatricial ectropion seems unavoidable. The latter can be prevented by complete suture of the palpebral fissure. In order not to destroy all the eyelashes, the operation may be performed by denuding with the lancet the edges of the lids behind the cilia and then suturing the lids together: Or, if it is possible, a narrow strip may be cut out of the skin of both eyelids near their borders, and the two raw surfaces united by sutures. If, however, the lid has been *completely* destroyed, and the eye itself has not suffered much, it is best to protect the eye by a moist chamber sufficiently long until cicatrization has ceased, and it is possible to perform a plastic operation, such as described for cicatricial ectropion.

If tarsorrhaphy is performed for pronounced exophthalmos, after the operation is completed, the rest of the palpebral fissure should be temporarily closed by several sutures without denudation of the lid-margin, in order that the flap may adhere firmly, and the sutures not tear out prematurely, owing to the strong tension.

If indicated for paralytic ectropion, a triangular fold of skin may be excised, as in senile ectropion, and the tarsorrhaphy combined with this; an operation resembling the Szymanowski method. In this manner the somewhat enlongated lid is shortened and brought to lie more closely against the eyeball.

Internal Tarsorrhaphy.—When Fuchs's tarsorrhaphy is performed at the internal angle of the lids, two precautions must be observed: (1) The internal canthus itself should not be touched by the operation. (2) The lachrymal canaliculi must not be wounded. The intermarginal incision is, therefore, made from the point (determined as before) to the end of the tarsus, i.e., to the punctum lachrymale. If the incision is made accurately in the intermarginal border and the lancet penetrates between the two surfaces of the lid, there is no danger of wounding the lachrymal canaliculus, as it is embedded in the tarsus itself. The same is true of the upper lid. In other respects the operation is the same as at the external angle. The horseshoe-shaped excision is retained and appears as a shallow depression. In this

way, if it should be desired to re-open the palpebral fissure in the future, a normally formed internal palpebral angle can be obtained.

In marked cases of exophthalmos it may be absolutely necessary to perform the **operation simultaneously at the outer and inner angles** of the lids, in order to transform the palpebral fissure into a short central aperture.

Median tarsorrhaphy may also be accomplished (**v. Arlt**) by removing, by means of forceps and scissors, a strip of skin from the

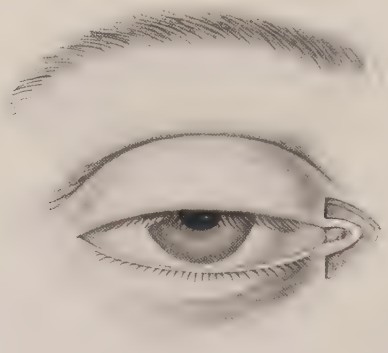

FIG. 37.—Horse shoe-shaped excision along the inner canthus from the skin of the upper and lower lids.

upper and lower lids near the inner angle, in such a manner that the wounds thus produced meet in a sharp angle at the internal canthus of the eye (Fig. 37). Three sutures introduced vertically unite the wounds and close the palpebral fissure from its inner side. This operating has the advantage of not injuring the cilia, so that an eventual re-opening finds the edges of the lids intact.

CHAPTER VII.

PTOSIS.

HESS'S OPERATION.

After previous shaving of the eyebrow **a horizontal incision** is made through the skin of the eyebrow along the entire length of the palpebral fissure to avoid disfigurement. The incision should be so placed that the short scar is completely covered by the eyebrow. The section includes only the skin, as a deeper incision injures large vessels, bleeding from which would disturb the further course of the operation. After the incision has been made, the skin is undermined downward with the knife beneath the convex border of the tarsus, i.e., to a point near the edge of the lid. The beginning of the **dissection** is made slightly more difficult by the numerous muscle-fibers which are inserted into the skin at this point. A little further down, however, the subcutaneous tissue is loose and easily separated with the knife. As the bleeding, even if present only slightly, interferes with the operation by collecting in the pocket constituting the field or operation, it is recommended to control the position and progress of the knife from without, through the skin. This may be done by pushing the knife downward in a perpendicular position, parallel with the skin, and fixing the skin at as low a point as possible (Fig. 38). The skin is thus undermined in the whole length of the incision with a few strokes, and a four-cornered pocket produced. In this way we can more readily avoid a buttonholing of the skin, than if we try to operate along the posterior surface of the skin with an insufficient view into the pocket, a procedure that is difficult with a small incision.

After the undermining is completed, **the insertion of the sutures** is begun. The strong silk threads are doubly armed with long, flat needles. In all, three sutures are employed, the first in the center of the lid, the two others to the sides. Both needles of the first thread are pushed through the lower part of the skin, at a distance of approximately 4 to 8 mm. from the edge of the lid. To accomplish this the skin must be fixed with the forceps, one blade of which remains

in the pocket, and the other lies on the skin at the point of intended transfixion, in order to prevent retraction of the lax skin and allow of insertion of the sutures just at the place determined on (Fig. 39). The needles with the thread are now brought out through the skin-wound and directed upward. In like manner, the outer and the inner sutures are inserted each about one centimeter from the middle stitch. Both ends of the middle thread are then pushed upward behind the upper edge of the wound near the periosteum, therefore, behind the muscle, and are brought out through the skin close to one another at about a

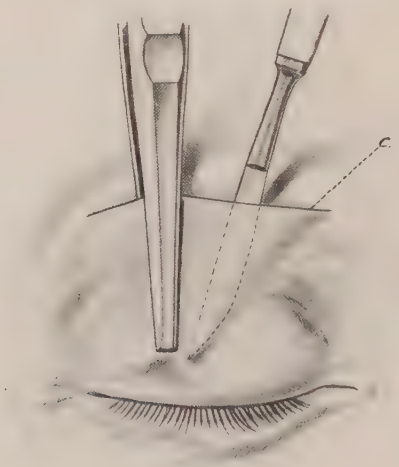

FIG. 38.—Hess's operation for ptosis. Method of undermining the flap. The forceps grasps the skin at as low a point as the progress of the undermining permits. The knife held vertically presses downward behind the skin and is observed by the operator from the front through the skin. (c), Section through the skin.

distance of $1\frac{1}{2}$ to 2 cm. from the incision. The outer threads are treated in the same way. The ends of the inner thread are not inserted directly perpendicularly, but should be inclined a little inward toward the median line.

The three threads are next tied over iodoform pads. This raises the lid and at the same time forms a fold in the skin corresponding to the point of entrance of the threads, similar to the normal fold of the lid. The above mentioned distance, as the insertion of the thread, varying from 4 to 8 mm. must, therefore, be adjusted according to the position of the fold of the lid on the other side. A fold lying too high is just as disfiguring as one too near the edge of the lid.

Slight traction on the threads raises the lids so that the palpebral fissure readily attains its normal width, but in tying the threads, they must be drawn up sufficiently to lift the lid higher than normally, i.e., to cause an over-correction. However, the threads should not be drawn too tightly, as this will make them cut through quickly, without materially elevating the lid more than with threads drawn moderately tight. The skin-wound is closed with several silk sutures.

The Dressing.—Immediately after the sutures are tied, a condition

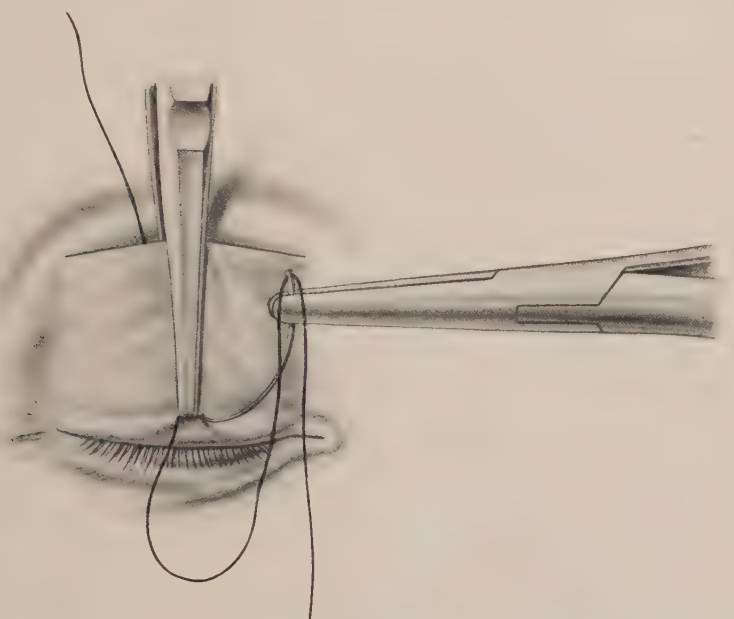

FIG. 39.—Application of the sutures. The forceps, one blade of which should be in front of, the other in the wound, grasps the skin just where the needle is to be inserted. One end of the thread has already been drawn through, the needle mounted on the other end has only just been inserted.

of total lagophthalmos is naturally produced. Because of this, the eye is covered with a celluloid shield, so as to produce a comparatively air-tight covering (Fig. 40). It suffices to fasten the shield along its border with adhesive strips, and, if extensive spaces exist between shield and underlying parts, they should be filled in with absorbent cotton. Within a few minutes the shield becomes moist, and under this dressing the eye may remain for weeks without the slightest sign of irritation. As the celluloid shield is sufficiently transparent to

permit a view of the eye, the dressing is changed only when secretion is present, and the eye must be cleansed.

After-treatment.—The sutures closing the skin-wound may be removed in from three to four days, but the sutures retaining the lid in its elevated position should remain undisturbed as long as pos-

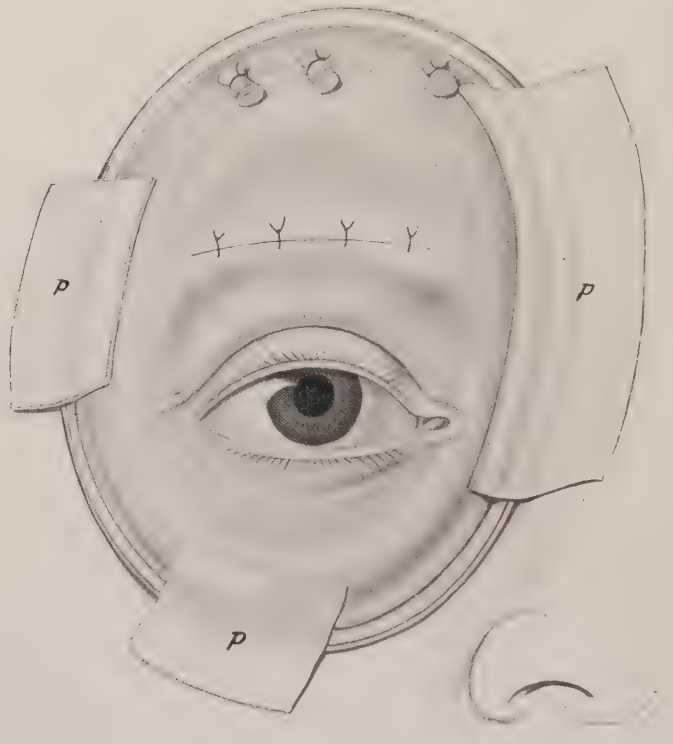

FIG. 40.—After treatment. The skin-wound has been closed by several sutures. The three fixation threads, of which the inner inclines a little toward the median line, are tied over pads. The lid, strongly elevated, stands off a little from the bulb, the new fold of the lid corresponding to the puncture points of the threads. For the protection of the eye, which cannot now be covered by the upper lid, a celluloid shield is employed; it is fastened at its circumference by strips of zinc oxide plaster, only a few pieces of which show.

sible—at the least, fourteen days; if they have not become loosened by this time, even longer—three weeks. By this time they are usually so loose as to have lost their hold and may be easily withdrawn after being cut through. The object of leaving the stitches so long is the formation of strands of scar-tissue along the threads, which not only unite the lid with the frontalis muscle, through which the threads have

been brought, but also serve as tendons by means of which this muscle elevates the lid.

The one indication for the operation is a case of ptosis in which *the patient absolutely shows distinct contraction of the frontalis muscle.* This most patients with ptosis are actually able to accomplish. The forehead lies in constant folds, and the skin of the eyebrow is constantly pulled far up over the upper border of the orbit, which would correspond to its normal position. In those who make no attempt to improve their ptosis by contraction of the frontalis muscle, the operation promises very little.

If the threads are drawn tightly and produce an over-correction it is not necessary to form a loop and tighten this frequently in order to maintain the lid in its normal position. The chances and results of the operation are always improved if the threads are pulled tightly at the outset. As the lid is not shortened by excision, but only by the pushed-up anterior (skin) flap of the split lid which unites at a higher point with the posterior flap and raises the lid, lagophthalmos need not to be feared. Of the many cases of Hess's ptosis-operation that I have performed personally or have seen at the clinic, this result has not occurred. This is certainly a strong point in favor of this method of operation. It is, however, to the disadvantage of the operation that we are not certain at the beginning of the terminal results. But this is not possible in any one of the many operations for ptosis which have been recommended. As yet, there is no method to enable us with certainty to make the palpebral fissure of the affected side exactly the same width as that of its normal fellow.

The results of Hess's ptosis-operation are in the great majority of cases very good; occasionally they are excellent, and but rarely unsatisfactory. Permanent over-correction need never be feared. In bilateral ptosis especially, it should be the operation of choice. It is easy of performance and the cosmetic results are excellent. The scar at the point of incision is later covered by the eyebrow, and if the sutures are properly inserted, a good position of the fold of the lid is obtained.

Anesthesia.—The operation may be most satisfactorily performed under cocain-anesthesia. One syringeful of a 1 per cent. solution (1 c.c.) suffices as injection into the skin of the eyebrow and lid. Before the threads are brought out at the upper point, a second syringeful must be injected into the tissues about the periosteum of this region.

Contraindications.—Apart from insufficient contraction of the frontalis muscle, the operation is contraindicated in those cases in which, in addition to the ptosis, there is paralysis of the superior rectus muscle or, as in some cases, a total ophthalmoplegia. If the eye, during sleep, is not drawn upward under the conjunctiva of the upper lid, there is danger of resultant disease of the cornea. This result may also be brought about by the occasional swelling of the skin of the upper lid after the operation, through an effusion or other edema projecting downward over the border of the lid. This coming into direct contact with the cornea may produce erosions and ulcerations, as has been my personal experience in two cases.

In this as in every other operation for ptosis, we must always consider the possible occurrence of diplopia, as the result of existing paralysis of the ocular muscles, after the correction of the ptosis. This would furnish just as important a contraindication to the operation for ptosis, as an abnormal position of the affected eye, for example, by secondary contractures after paralysis.

PAGENSTECHER'S SUTURES.

The stitches in Hess's method of operation are essentially the same as those recommended by Pagenstecher. The great efficacy of Hess's operation is due to the change in position of the anterior layer of the

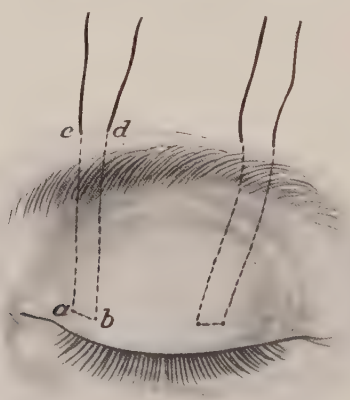

FIG. 41.—Pagenstecher's suture.

lid brought about by the sutures. Pagenstecher's sutures should be used only in the slightest forms of ptosis. As the stitches are allowed to remain in place for a long time, it is best to employ a wire suture,

the upper end of which is shortened by twisting, producing a sufficient elevation of the lid. In order to avoid scarification of the skin, the sutures are introduced subcutaneously (Fig. 41). From the point of entrance at the one end, the suture is carried up and brought out above the eyebrow through *c*. The other end of the suture is carried outward subcutaneously for 2 mm. from *a*, and then withdrawn at *b*. The needle is re-inserted at the same point *b* and brought out above, either at *c* or at *d*. It is then twisted over a gauze pad. The one suture is inserted at the inner third, the second suture at the outer third of the lid.

EVERBUSCH'S OPERATION.

Indication.—The advancement of the levator palpebræ is an operation intended to overcome ptosis brought about by a paresis of this muscle. The object of the operation is to make the weakened muscle stronger by shortening and suturing its point of attachment further forward. The first part of the procedure is to lay the muscle bare. This is not so easy in living patients. Anesthesia is produced at the beginning by cocainizing the conjunctiva, and later by injecting 1 cc. of a 1 per cent. cocain-solution under the skin and into the deeper parts of the lid.

The Dissection.—A longitudinal incision through the skin of the lid and the orbicularis muscle, is made midway between the arch of the eyebrow and the border of the lid. The eye is protected by a horn-plate placed between it and the lid. By undermining to some extent both borders of the lid-wound, it is easy to expose below the upper border of the tarsus, and above, the thin tarso-orbital fascia. In order that the preparation of this part of the operation may be readily understood, it is well to briefly recall the **topographical relations** in this region.

If a **sagittal section** is made **through the orbit** near its middle, the appearances seen are approximately as follows (Fig. 42).

The border of the orbit, *b*; attached to this is the fascia tarso-orbitalis (*f. o.*), which hangs down like a curtain and becomes thickened below at the tarsus (*ta*); in front of it, the fibers of the orbicularis (*m.o.*) and the skin with the lashes at the free border of the lid; behind it and passing forward on the roof of the orbit, the levator palpebræ (*m.l.*), which spreads out at the orbital opening like a fan; its aponeurosis joins the fascia tarso-orbitalis, so that immediately above the

upper border of the tarsus no more than a membrane is visible—the tarso-orbital fascia, which has united with the aponeurosis of the levator palpebræ. A cut through the fascia at this point, would come directly upon the conjunctival fornix (*c*) and would not touch the muscle.

If, however, the cut is made slightly higher, carefully piercing the

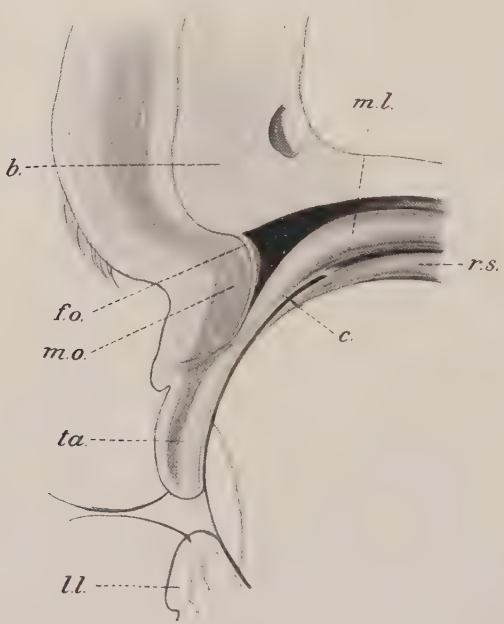

FIG. 42.—Sagittal section through the lids and the anterior portion of the orbit. b. Upper border of the orbit; f. o., The tarso-orbital fascia, which is attached to the bone, hangs down and blends with the tarsus (ta.). The levator muscle (m. l.) passes forward above the superior rectus (r. s.), changes here into a fan-like tendon, which, joined by the tarso-orbital fascia, is inserted into the upper part of the tarsus. Behind the tarsus is seen the conjunctiva (c), in front of it the orbicularis muscle (m. o.). l. l., represents the transverse section through the lower lid.

fascia, which at this point is thin, there will readily be seen the radiating red bundles of the muscle which may be traced upward into its compact body. Therefore, the fascia must be incised at from 5 to 6 mm. above the tarsus; at this point the muscle-bundles of the levator palpebræ will be exposed (Fig. 43).

Three sutures must now be inserted through the muscle in the same manner in which they were inserted in the advancement of the

recti muscle—first through the middle. With a fairly strong curved needle the middle of the muscle is transfixed in its entire thickness, the horn-plate remaining in place, at as high a point as possible; the same stitch is repeated with the same needle. In this manner a loop is produced by the drawing together of which the middle fibers of the muscle are constricted. A second loop is placed to its inner side (Fig. 44), and a third loop to its outer, both at the same height. Now the muscle is cut through, 2 mm. below the threads, along the entire

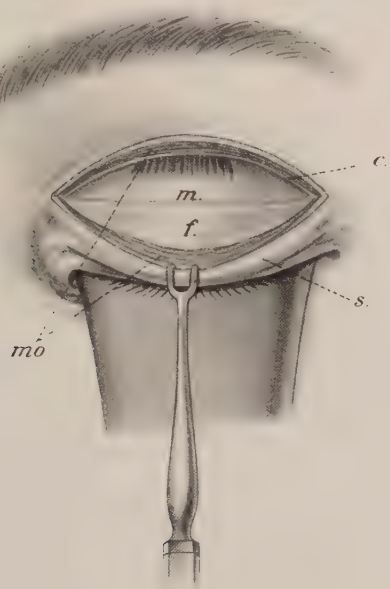

FIG. 43.—Everbusch's operation for ptosis. The incision made midway between eyebrow and border of the lid through the skin (s) and orbicularis muscle (m. o.) is held open by tenacula. The tarso-orbital fascia is also cut near the upper margin of the wound (the border of the wound (c) is visible as a white line) and turned down in such a way that the transition of the levator palpebræ muscle into its tendon is plainly visible in the wound; at m, it blends with the tarso-orbital fascia.

length of the lid, and a piece excised 3 to 5 mm. or more broad, that is, downward to the upper border of the tarsus or even including a small piece of the tarsus itself. The conjunctiva as far as it comes within the reach of the piece to be excised, need not be saved, but may be removed with the muscle. However, with slight care, it is not difficult to excise the piece of muscle without injuring the conjunctiva; but when a strip of the tarsus is included, the conjunctival covering cannot be preserved, as it is too intimately adherent.

The gaping wound is closed either by bringing all six ends of the threads between the tarsus and the orbicularis muscle, through the intermarginal space and tying them over rubber tubes; or, *as I prefer*, by sewing the ends of the catgut threads to the anterior surface of the tarsus so that the upper cut-edge of the muscle is drawn over the cut-edge of the tarsus to its anterior surface, to which it heals (Fig. 45).

The skin-wound is closed over these sutures with several stitches (Fig. 46). This method of operation has the advantage that the margin of the lid is in no way disfigured. If the threads are drawn through

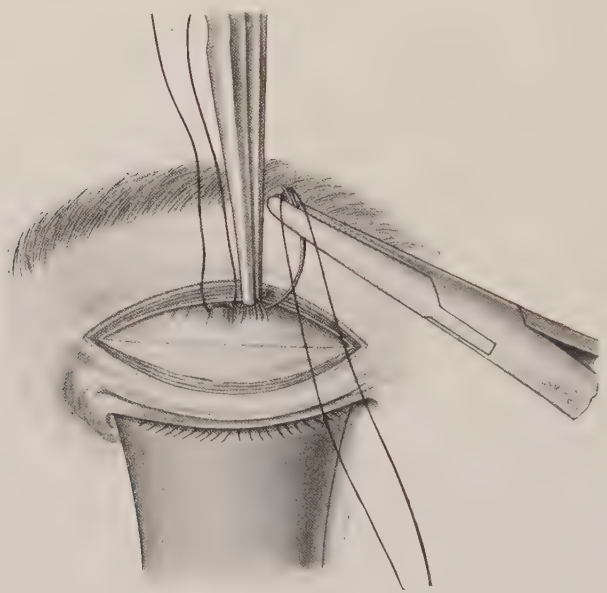

FIG. 44.—The middle thread has already been inserted. The second stitch is just being inserted; to do this the operator lifts the lateral part of the muscle with forceps in the form of a fold and pushes the needle through the entire thickness of the tissue.

the intermarginal space and tied there, the underlying materials, glass-beads, gauze-pads or rubber-tubes, almost invariably induce a circumscribed and superficial necrosis of the margin of the eyelid, as the stitches must remain a number of days. The lashes fall out in the necrotic area, and occasionally the scarification may bring about a high grade deformity of the lid-margin, even to incurving of the lashes—trichiasis. Because of this, the margin of the lid should, if possible, be spared.

The result of the operation is in most cases good, although it is

difficult, and even impossible, to determine exactly just how much muscle should be excised to attain the desired result. Caution must be exercised during the operation to limit the excision of the lid sufficiently to prevent resultant lagophthalmos. On this account the piece to be incised should never be broader than 5 mm.

Contraindications.—This operation is, however, only suitable when the levator is not completely paralyzed. This is ascertained by

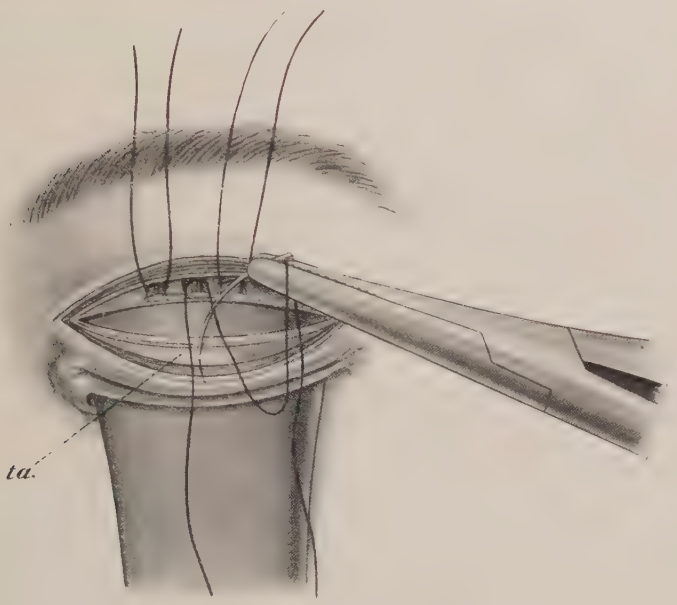

FIG. 45.—After excising a strip of muscle (and conjunctiva) 5 mm. broad, the middle pair of threads is first fastened on to the anterior surface of the tarsus (ta); during the tying the end of the cut muscle is pulled onto the anterior surface of the tarsus and heals thereon.

asking the patient to close both eyes as in sleep, so that the superciliary ridge may be brought in its normal position immediately on the upper border of the orbit. The skin of the superciliary region must then be fixed in its position on both sides by firm pressure with the thumbs. If now, the patient at command can open the eye even though only to a limited extent, there is proof of some action of the levator, and the muscle is not completely paralyzed. We may then expect success from the operation of Everbusch.

SUMMARY.

Hess's operation yields good results only when the patient is able to raise the lid through contraction of the frontalis muscle; otherwise, not much improvement can be expected. Occasionally after performing Hess's operation, it is noticed that the patient, having the same degree of ptosis as before, lifts the operated lid, even to the normal breadth of the lid-fissure, only in the moment when the sound eye is closed. The explanation for this may be found in the fact that, not until the sound eye is closed, can the patient contract his frontalis in order to elevate his palsied lid. When contraction of the frontalis on the operated side, while the sound eye remains open, does not

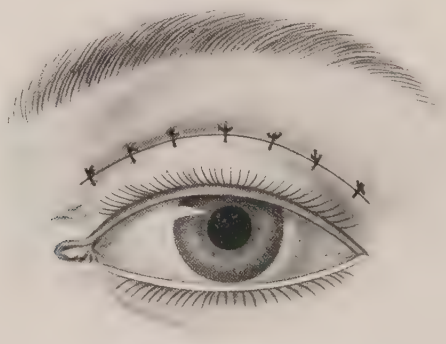

FIG. 46.—Appearance of the lid after the operation. The skin-wound is exactly approximated by several sutures. The edge of the lid remains perfectly intact.

seem possible to the patient, it is not attempted. Likewise, after a Hess's operation has been performed on one side, the patient can open this eye to its normal width, but only with great elevation of the lid the other eye through excessive simultaneous contraction of the frontalis. The bilateral innervation of the frontalis muscle brings about in such individuals an excessive widening of the palpebral fissure on the sound side, while effecting only the normal opening on the affected side. Only in bilateral ptosis can we expect, with certainty, good results from Hess's operation; and, no matter what operation is performed it is impossible in unilateral ptosis to restore and maintain the palpebral fissure to *exactly* the same width as on the normal side. In any case, the operation should be performed whenever possible under local anesthesia, as in narcosis even a superficial comparison of the new fissure with that of the sound side is impossible.

On the other hand, it must be remembered, that in local anesthesia the swelling of the tissues through the subcutaneous injection makes it also rather difficult to correctly estimate the width of the palpebral fissure.

The method of Panas, performed considerably at one time, for cosmetic reasons alone is inadvisable and need not be described.

The method of Motais, recommended recently by several French operators, depends upon the suturing of the superior rectus to the upper margin of the tarsus. It has the great disadvantage of interfering with the function of this muscle; and a permanent diplopia may follow its performance.

CHAPTER VIII.

THE EYE-MUSCLES.

TENOTOMY.

In **tenotomy of the rectus internus,** the left hand, holding a pair of toothed forceps, raises a fold of the bulbar conjunctiva at a distance of 3 mm. from the limbus. A short vertical incision, about 5–7 mm. long, is made with a small, slightly curved scissors. The nasal border of the wound is then lifted up with the forceps and the subconjunctival tissue severed and undermined by short cuts with the scissors. The closed forceps, held parallel to the sclera, are now introduced into the wound, the internal margin of which is slightly raised by the assistant to facilitate this introduction, till they reach the insertion of the muscle (5 mm. from the limbus). They are then opened, pressed against the sclera, and through shutting them the tendon is grasped. The forceps are now rotated into a position perpendicular to the sclera, and the tendon divided close to its insertion by the scissors held in the right hand. In making this division, one blade of the scissors is pushed behind the tendon, as shown in the illustration (Fig. 47).

Not a particle of the tendon should remain adherent to the sclera, and after its separation only a slight ridge should mark its point of insertion. The muscle is immediately released, as pulling with the forceps is painful. The scissors are laid aside, and a curved strabismus hook, taken in the left hand, is pushed into the wound, close to the sclera, and moved upward and downward in order to determine whether all of the tendon-fibers have been severed. Any fibers which have not been divided will offer a tense resistance to the hook, when the latter is drawn forward. These fibers must also be separated close to the sclera. If the hook becomes caught in the capsule of Tenon, it pulls out a delicate membranous fold, which must not be mistaken for tendon-fibers. Incisions of Tenon's capsule are likely to produce undesirable results. After all the fibers are separated, the wound is closed with one or two **catgut-sutures,** which are introduced in a direction from above downward. While the needle is being passed

through the conjunctiva, the membrane should be firmly fixed with the toothed forceps and the needle held close against it, as pulling on the conjunctiva will cause the patient unnecessary pain.

The execution of the tenotomy itself is the work of an instant. The operation is best performed under **cocain-anesthesia.** The experienced operator may anesthetize the conjunctiva alone, by dropping

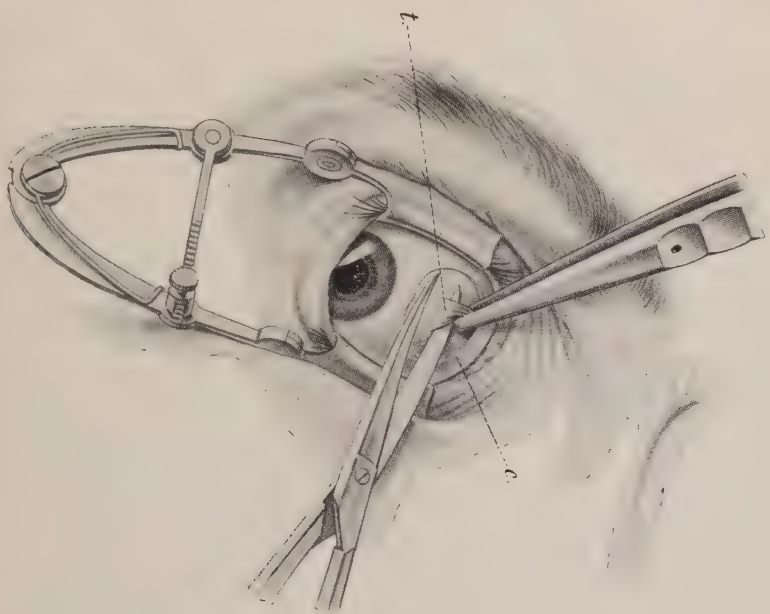

FIG. 47.—Tenotomy of the rectus internus. The eye is placed in the position of abduction. A small incision is made in the conjunctiva (c). The forceps, after seizing the muscle, are held perpendicular to the curvature of the eyeball. One blade of the open scissors is introduced immediately behind the muscle at its insertion, the other blade lies in front of it. A single snip with the scissors severs the tendon (t) at its insertion.

the cocain-solution into the eye. In sensitive patients, or if the operator is inexperienced, it will be advisable to make a subconjunctival injection of a 1 per cent. solution of cocain immediately over the tendon of the muscle, employing a quantity of $\frac{1}{3}$ cc. The manner of holding the instruments is the same whether the tenotomy is performed on the right eye or the left eye. After the operation a slight dressing is

applied which may be removed the following day, or at most two or three days later.

In **tenotomy of the external rectus** the incision through the conjunctiva is made slightly further from the limbus, on account of the more remote insertion of the tendon of this muscle (7 mm. instead of 5 mm.). Otherwise, the technique of the operation is exactly the same.

ADVANCEMENT.

In the operation of advancement the conjunctival sac is first cocainized, followed in every case by a subconjunctival injection of a 3 per cent. solution of cocain ($\frac{1}{2}$ cc.). A fold of conjunctiva is lifted up over the tendon of the muscle, and the needle of the syringe introduced against the sclera and directed along the axis of the muscle toward the canthus. While this injection is being made, the needle must be pushed farther in, in order to better anesthetize the deeper parts. The resultant swelling may be dispersed by slight massage.

Sufficient space for the performance of the operation is obtained by a **short vertical incision** through the conjunctiva, as in tenotomy, in addition to which a **long horizontal incision** is made, beginning at the middle of the first cut, and running perpendicular to it toward the canthus. The wound is thoroughly undermined by small cuts with the scissors, after which the muscle is seized with the forceps in the manner previously described.

The tendon is now held with the forceps, and the eye is rotated in the direction opposite to the action of the muscle, while the latter is loosened from its bed by a few strokes with the point of the closed scissors, which is made to glide along its upper and lower margins. A straight strabismus hook is then passed beneath the muscle, either from above or below. If the point of the hook is covered by the conjunctiva or the capsule of Tenon, it must be freed, and the second strabismus hook is thereupon introduced in the opposite direction. Muscle-fibers will frequently be caught by this hook which escaped the first one. If the muscle is not yet cleanly dissected, the overlying tissue must be separated with the scissors, the cutting always following the direction of the muscle. If it is done transversely, that is, vertical to the muscle-fibers, it may happen that a considerable part and sometimes even the entire muscle is severed, thus making the operation much more complicated. It is important for the assistant to remember

that he should stretch the muscle by means of the two strabismus-hooks only when desired by the operator, as tension on the muscle always causes pain.

The suturing is now done. While the sutures are being inserted, the assistant must **stretch the muscle.** This is effected by the anterior strabismus hook drawing the eye in a direction opposite to the action of the muscle, while the other strabismus hook is moved in the direction of the muscular contraction. A moderately thick **silk thread,**

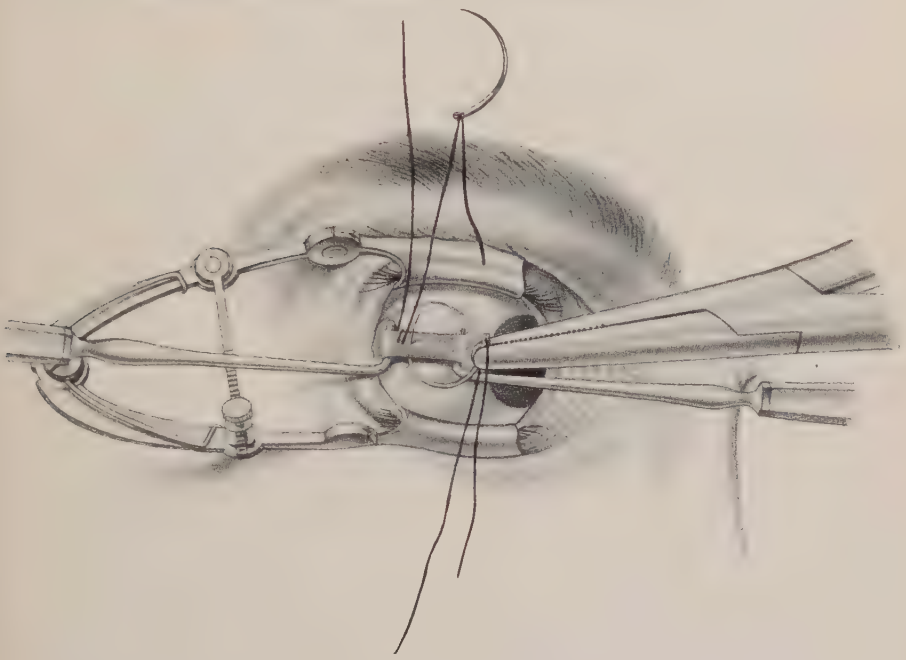

FIG. 48.—The eye is placed in the position of adduction. The freed muscle is stretched over two strabismus-hooks. The upper suture has already been pulled through; the lower suture is being introduced.

upon the strength of which we can rely with certainty, is used. The threaded needle is passed from within outward through the muscle near its middle close to the posterior strabismus-hook. Half of the suture is drawn through, and the needle is again passed in the same manner at the same point. The loop thus formed is made to firmly grasp the muscle-fibers. It makes no difference whether the needle is first passed through the upper or lower half of the muscle. The other half of the muscle is then included in a loop of thread introduced at the same distance from the insertion of the tendon (Fig. 48)

and laced up in the same manner. The ends of the suture containing the upper half of the muscle are laid upward, and those of the lower half downward, or a white and a black suture may be used in order that the wrong ends of the threads may not be tied, when this stage of the operation is reached. After the sutures are introduced, the operator divides the muscle with one snip of the scissors, about 2 mm. in front of the threads; closer than this, the loops are liable to slip off. The stump of the muscle still adhering to the sclera, is now removed close to the scleral surface, leaving only a short piece at one end of the insertion, to allow fixation of the eye with the forceps.

By the foregoing procedures, it is seen that the muscle is shortened to a certain extent, and it must now be not only re-attached to the bulb, but fastened so that its influence is more strongly felt, i.e., its insertion must be brought nearer to the limbus, hence the term: advancement. For this purpose, the needle of either suture is passed near the limbus through the superficial layers of the sclera, the thread of the upper loop corresponding to the upper half of the original insertion, and *vice versa.* The sclera in front of the insertion must first be laid bare by separation of the conjunctiva, as the muscle naturally can only unite with a raw surface. For this suture, it is best, to employ a *thin flat needle*, not the thick and triangular needles, as these would have to be introduced deeply to prevent cutting through.

With a normally thick sclera there is **no danger of perforating** the bulb, if the needle is held parallel to the curvature of the sclera, so that only the most superficial layers are taken up. The needle point must not be placed vertically against the sclera in order to penetrate its fibers. The only unpleasant feature is that the needle may be passed too superficially and soon cuts through. If this happens, a fresh attempt must be made to catch some of the adjacent scleral fibers, a few of which are sufficiently strong to allow the operator to draw the eye, by means of the suture, in the direction of the muscle and to fasten the latter firmly to the globe. In making this suture, the needle is inserted in the direction of the muscle, i.e., horizontally, and the thread fastened to the sclera in front of either the upper or the lower half of the tendon-insertion, according to which suture is being tied. The attachment is made as close as possible to the limbus, but care should be taken that the knotted thread does not injure the cornea by pressure. The position of the knot should, therefore, be at least 1 mm. from the limbus, so that it does not press upon the

cornea. For this reason, it is advisable, and for the less skillful operator easier, to pass the needle through the sclera parallel to the limbus, i.e., perpendicular to the axis of the muscle. The needle of the superior suture must, therefore, be brought from the horizontal meridian upward, while that of the inferior suture goes from the same point downward. Such a direction of the sutures has also the

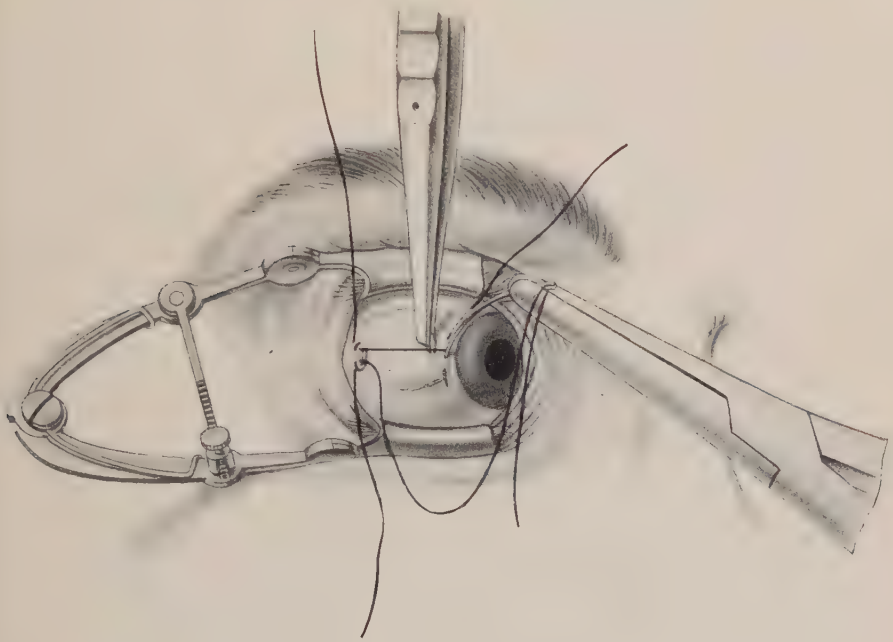

FIG. 49.—Advancement of the rectus externus. The muscle is divided; a piece excised; the eye is held fast by forceps applied to the stump of the tendon, which has been allowed to remain. The upper suture has already been drawn through the sclera near the limbus and also through the conjunctiva. The needle, which has been applied flat against the sclera, has already penetrated slightly the superficial lamellæ.

advantage of lying perpendicular to the direction of the scleral fibers (Fig. 49).

After the needle has been fixed into the sclera, it is passed a little further upward or downward through the conjunctiva. This affords not only an additional hold for the suture, if the attachment to the sclera is not sufficiently firm, but closes simultaneously the wound in

the conjunctiva. Only one end of each suture is passed through the sclera.

Now a surgical sling is prepared in both the upper and the lower sutures. Then, while the assistant seizes with the forceps the eyeball at the opposite limbus and rotates the bulb in the direction of the operated muscle, each suture is drawn as tight as possible, and a second knot is made over the first (Fig. 50). The sutures must be drawn firmly in order to be certain that the muscle has actually been brought for-

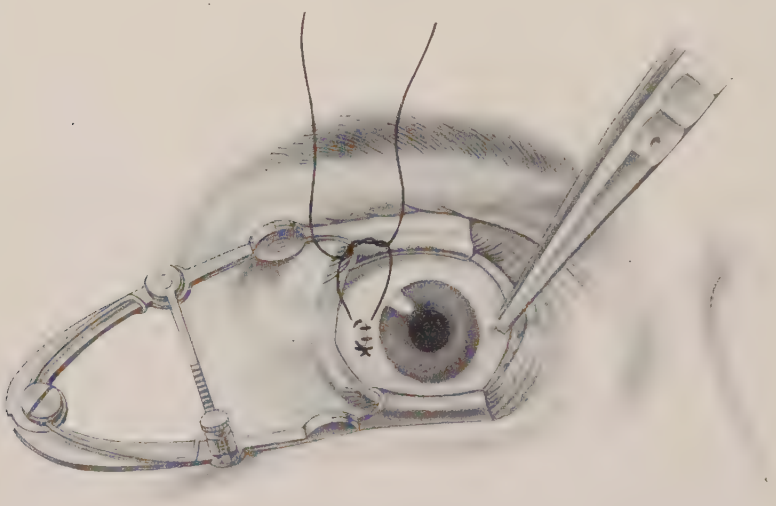

FIG. 50.—The operation is almost completed. The eye is rotated outward by the forceps, which are fastened at the inner side. The lower suture has already been tied; the upper has still to be pulled together. The conjunctiva covers the wound spontaneously.

ward to the limbus and fastened there. If the sutures have not been brought together properly, the muscle will be weakened rather than strengthened by the advancement.

A suture of the conjunctiva is usually unnecessary as the wound has already been closed perfectly by the advancement-sutures. If this, in an isolated instance, should not be the case, there is no objection to a conjunctival suture. The operation is the same for either the rectus internus or externus. The threads are cut off short, and care exercised that

they do not come in contact with the cornea. After the operation a **dressing** is applied to **both eyes,** as the prevention of all ocular motion will protect the recently sutured muscle in its new position and make secure its attachment to the limbus.

After-treatment.—When possible, as in hospital-cases, both eyes should be kept closed for three days, but the dressing is changed on the day following the operation, in order to ascertain whether or not the cornea is uninjured. The sutures may be removed on the fifth or sixth day after the operation, but if a pronounced swelling of the conjunctiva prevents ready access to the knots, there is no objection to allowing the sutures to remain longer, as they can be removed later with much greater facility. On the whole, the reaction of the conjunctiva to this operation is usually slight. The eye exhibits no irritation or pain, and in a short time there is only a slight thickening of the conjunctiva to mark the point of operative interference.

If the patient's sound eye cannot be bandaged (as in the case of ambulant patients, who must go home alone), it is advisable to keep the muscle at rest by introducing a suture through the conjunctiva close to the limbus, and carrying the ends through the canthus to the external skin, where they are tied. In this way it becomes impossible to rotate the eye toward the side opposite to that of the advanced muscle.

The Fixation of the Muscle to the Limbus.—While it is our custom to suture the muscle directly to the sclera, by passing the needle through its most superficial layers, as has been described, it is proper to discuss here another common method. This consists in passing one end of the upper suture upward beneath the conjunctiva along the limbus, going almost as far as the upper end of the vertical meridian, and, in a similar manner, one end of the inferior suture is passed beneath the conjunctiva as far as the lower end of the vertical meridian. In this way an attempt is made to obtain sufficient hold for the muscle in the conjunctiva. When the sutures are tied, the muscle is, of course, drawn forward to the limbus, and must naturally split. On the other hand, the ocular conjunctiva also yields to the tension, and is stretched in the direction of the tendon, obliquely across the cornea. Quite apart from the fact that this attachment is not dependable, on account of occasional friability of the conjunctiva, the method has still a greater drawback—namely, that the conjunctiva lies from above downward in a tensely drawn fold across the cornea. Again, it can easily happen that the suture will come to lie upon the cornea, especially

if it is not drawn sufficiently tight, a fact which may pass unnoticed by the operator, as the knot is covered by the conjunctiva. A corneal ulcer may thus be produced, which will make the prognosis bad, as these ulcers show little tendency to heal. The operator is then forced to remove the sutures at once sacrificing the entire success of the advancement. Therefore, preference should be given absolutely to the direct suturing to the sclera. The only contraindication to this would be a pathologically thinned sclera (**ectasia**).

APPLICABILITY OF STRABISMUS-OPERATIONS.

Before performing a strabismus operation, two conditions should be investigated—the **degree of deviation** of the affected eye, and the **mobility** of the eyes. It may be incidentally mentioned at this time that a preliminary **accurate determination of the ocular refraction** under the influence of atropin is an absolute necessity. The same degree of strabismus may in one case call for a tenotomy, and in another make an advancement of the muscle desirable. Furthermore, it must be clearly understood how much effect is likely to be produced by a tenotomy or an advancement. For example, how many degrees of the squint in an eye with convergent strabismus may be overcome by a correctly performed tenotomy of the rectus internus, and how many by an advancement of the rectus externus? The exact determination of this is not possible. It is commonly believed that tenotomy of the rectus internus corrects to the extent of 15 degrees, but very often there is produced decidedly less correction, sometimes even very much less. And, while at times the final result of a tenotomy after the lapse of some time shows little change in the degree of squint, in other cases the effect is unexpectedly great, so that the commonly given figures are far exceeded. As stated clearly above, this applies only to a correctly performed tenotomy. It would not be surprising to find an enormous change in the position of the eye after extensive incisions of the conjunctiva, the subconjunctival tissue and Tenon's capsule, or to get no result at all when some of the muscle-fibers were overlooked. But even in performing the operation in the most approved manner, the effect may be decidedly influenced, not only by preexisting physiologic variations in the distance of the muscular insertion from the limbus, in the strength of the muscle, and in the relations of Tenon's capsule, but also, and sometimes to a considerable degree, by definite even though only slight variations in the degree of separation of the subconjunctival

tissue and capsule resulting from the operation. It must also be remembered that the immediate result of an operation may differ greatly from the more remote, permanent result.

From the foregoing it is readily understood that the degree of correction after tenotomy of the rectus internus cannot be foretold with certainty. But even if the effect of a tenotomy were definitely known in advance, there would still remain many perplexing problems for the operator. It would naturally be most uncommon for the degree of a strabismus to correspond exactly with the degree of change in position produced by severance of the tendon. Therefore, the necessity for some means of regulating the effect of a strabismus operation is at once recognized. With such means at hand one does not need to know accurately in advance how much effect the operation will have. Hence, for altering the effect of a tenotmoy there are introduced what are termed supporting and counteracting sutures.

The supporting suture is inserted by means of a short, moderately curved needle, into the conjunctive *close to the external limbus in the horizontal meridian.* In this situation the conjunctiva is firmly attached to the coats of the eye. If the suture is placed more externally only a fold of conjunctiva will be pulled forward by it, and it will be impossible for it to exert an appreciable influence upon the position of the eye. The suture is introduced in the horizontal meridian, because the eye should be rotated outward accurately on its vertical axis; if the fixation is made above or below the horizontal meridian, the rotating of the eye will occur on other axes, which would produce undesirable results. In order to fasten the suture firmly, it is advisable to introduce the needle twice, once immediately above and once just below the horizontal meridian. In those occasional cases in which the conjunctiva is easily lacerated, there should be no hesitation in penetrating somewhat deeper with the needle in order to fasten the suture in the episcleral tissue beneath the conjunctiva. Both ends of the silk-suture are then passed in the horizontal meridian through the external canthus out to the skin. In doing this, the needle is made to penetrate the canthus rapidly, while the outer angle of the eye is stretched between two fingers. By tying both ends of the suture finally over a small gauze compress, the operator is in a position to rotate the eye outward at will.

The problems now confronting the operator are the following: How far outward should the eye be rotated? How great is the effect

of this supporting suture, and when should it be applied? The application of the suture is naturally limited to those cases in which convergent strabismus still exists after the tenotomy but in which at the same time the loosened muscle is not too much limited in its efficiency. It follows, as a matter, of course, and this is an important rule after every strabismus-operation, that the position of the eye should be controlled immediately after completion of the operation. This is best done by having the patient, while still lying on the operating table, fix his gaze with both eyes open upon a point on the ceiling of the room. It can then be readily determined how much improvement in position has been accomplished by the operative interference. Then, by having the patient fix upon the operator's finger, while it is moved toward him in the sagittal plane, the convergence-ability of the eye can be determined, and, by laterally conducted movements, also the adduction-power of the severed muscle. The suture should not be used in those cases in which the muscle appears considerably weakened, even though there still remains some strabismus. As the suture rotates the eye outward, the insertion of the muscle will come to lie still further from the limbus than after a simple tenotomy, and through this the muscle will lose still more in efficiency. If there is pronounced weakness of the muscle, a divergent squint will soon develop, owing to the marked preponderance in strength of the intact rectus externus.

In accordance with the rule **always to be satisfied with a slight undercorrection** in the operation for convergent squint, the eye should not be rotated outward to its greatest extent by means of the suture, although it is known that the eye rolls inward again after removal of the suture. At the most, therefore, it is permissible to pull the suture sufficiently tight to produce a slightly divergent position. It is not necessary to allow the suture to remain over twenty-four hours. The final effect of the suture cannot be estimated accurately in degrees. As already mentioned, the eye usually rolls inward again to a slight extent. The influence of the supporting suture is closely related to the size of the incision into Tenon's capsule. **Lateral incisions in the capsule of Tenon,** which are also recommended to increase the effect of tenotomy, must certainly be made to some extent in the performance of every tenotomy.

A great advantage lies in the possibility of introducing this suture one, two, or even three days after the tenotomy. It happens occasionally that the correction produced by a tenotomy is entirely satisfactory

immediately after the operation, but in the next few days, to the great astonishment of the operator, the effect diminishes considerably and the degree of strabismus increases correspondingly. The suture is, therefore, the most acceptable means of reproducing the original result. After cocainizing and re-opening the conjunctival wound, a strabismus hook is employed to separate the fresh adhesions that have formed since the operation, after which the suture may usually be introduced with gratifying results.

The counteracting suture is applied as follows: A suture is introduced through the conjunctiva close to the internal limbus, in the same manner as previously described for the supporting suture at the external limbus. The inner border of the wound is then raised by means of toothed forceps, and if a pronounced effect is desired, an attempt is made to grasp the muscle itself with the forceps. The needle is then pushed deeply into the subconjunctival tissue and is brought out near the internal canthus about the point of the caruncle. The whole region must previously be anesthetized by a cocain-injection. The other end of the suture is passed in the same way, and the two ends are tied firmly. The eye is thereby rotated inward, so that the recently divided muscle with its tendon is again brought closer to the limbus, and thus gains in power. The fixation of the silk-thread in the conjunctiva at the limbus is sometimes difficult, particularly if the conjunctival incision has been made close to the limbus. If the conjunctiva is easily torn, and does not offer sufficient hold for the suture, no other course is left open but to fasten the suture in the superficial layers of the sclera.

This suture must invariably be employed if an over-correction has resulted from the tenotomy. If the eye shows a tendency to become divergent immediately after the division of the tendon, and if the powers of adduction and convergence of the eye have been greatly interfered with by the operation, the omission of this suture would constitute a serious mistake. The highest grades of divergent squint may follow such unfortunate tenotomies. As in the case of the supporting suture, this counteracting suture may also be introduced one to three days after the tenotomy. It is only necessary first to break any existing adhesions by means of the strabismus hook. The suture is always tied firmly so that it produces a decided convergent position of the eye. In over-correction of the eye, it is not likely that too much counteraction will be produced. The suture should be allowed to remain several days.

As mentioned before, all of the methods described here refer to tenotomy of the rectus internus.

Tenotomy of the external rectus plays a much less important part in the operation for divergent strabismus, than does tenotomy of the internal rectus in the operation for convergent strabismus. This subject will be considered later, and in the meantime the discussion will be continued regarding the operation for convergent strabismus.

The Extent of the Effect Produced by Advancement of the Rectus Externus.—Still less accurate figures can be given here than in the case of tenotomy. The variations in the extent of the results should not occasion surprise, and it would be extremely naive, if we could believe that each millimeter of excised muscle will produce exactly the same degree of correction in every case, or that a certain degree of strabismus will be overcome by the excision of so many millimeters of muscle in accordance with an inflexible rule. A change of 30 degrees in the position of the eye is the most that can be expected from an advancement; usually it is much less, and may be put down at 20 degrees at an average in an operation with normal course.

In the method which has been described, there are two **means of influencing the effect of advancement**—the excision of a piece of muscle, and the suture of the insertion in front of the original point of attachment. The last plays a more important part than the excision. If the operation is limited merely to the excision of part of the muscle, and the muscle again sutured to the original point of insertion, the effect of the operation will be slight. Of decided importance is the approaching of the new point of insertion of the muscle toward the limbus.

There is no danger of producing an over-correction by performance of advancement alone. Even in a convergent strabismus of no more than 20 degrees one may safely excise the longest possible piece of the muscle and suture the remainder in an advanced position without producing thereby a divergent strabismus. It must also be taken into consideration that the result evident immediately after the operation is at its maximum, and that the effect usually diminishes somewhat in the near future. Therein lies an important contrast with the effect of a tenotomy. While an over-correction must be strictly avoided in the performance of tenotomy, on account of the increasing degree of divergent strabismus that is inevitably produced, any over-correction that may occur during the performance of an advancement need not worry

the operator. No increase in the divergence is to be expected; on the contrary, a retrogression is certain to occur.

Incalculable results may follow **simultaneous advancement of the rectus externus and tenotomy of the rectus internus of one eye.** Even though a considerable degree of convergent squint with good adduction-power of the eye remains after a tenotomy of the internal rectus, an immediate advancement of the rectus externus is a risky procedure. The effect accomplished is often enormous, and a high degree of divergent strabismus may be the immediate result. As a result of the preliminary tenotomy, the advancement not only produces changes in the region of the external rectus, but also weakens the action of the internal rectus. Through advancement of the rectus externus the eye is rotated outward, and owing to the lack of resistance on the part of the divided rectus internus, this rotation is greater than it would be with a normal internal rectus. The result is necessarily the same as that produced by a supporting suture. The rectus internus is drawn further away from its original point of insertion toward the equator of the eye, and loses correspondingly in its influence.

The simultaneous performance of tenotomy and advancement can be recommended only for the highest grades of convergent strabismus. Even in these cases the operation has to be limited to a resection of the muscle, and the suture made through the original point of insertion. If an over-correction is produced, it should by no means be allowed to remain, as the resulting divergent strabismus will rapidly increase in degree. It is necessary to introduce immediately a counteracting suture, which must be well buried in the superficial layers of the sclera at the internal limbus, to prevent the thread from tearing out. Should this not be sufficient, the operator must remove the sutures of the advancement and fasten the muscle further backward. The removal of these sutures after an interval of two or three days will no longer have any effect on the result of the operation.

From a physiologic standpoint, advancement must be given the preference. It increases the motility of the eye, while tenotomy causes a diminution or loss in motility. Therefore, although the pathogenesis of strabismus may indicate tenotomy as the operation of choice for the correction of convergent squint, advancement must be recognized as of greater value physiologically. This should not be understood, however, as meaning that an advancement must be performed under

all circumstances; in fact, it cannot be denied that in many cases tenotomy is an indispensable operation.

In order to give some **general indications for procedure in overcoming convergent strabismus,** the following **rules** may be formulated, based upon the preceding considerations:

If the squinting eye is amblyopic, the operations are preferably performed upon this eye, so far as the consideration for its mobility will allow; however, an interference with the other eye is usually allowable.

In convergent strabismus of *slight* degree (maximum 15 degrees) tenotomy of the rectus internus of the affected eye is the first consideration. An examination of the new position of the eye must be made immediately after the operation and in accordance with the points of view previously pointed out, in order to determine whether or not a suture, and which suture, is necessary to change the effect. Only rarely will it be found that the tenotomy has produced exactly the result desired. If the tenotomy is succeeded by a marked diminution in the motive power of the rectus internus, all thought of *immediate* further interference must be abandoned, even though a convergent squint still remains.

Tenotomy is the operation of choice in cases with normal motility of the squinting eye, while advancement is preferable if the abductive power of the eye is materially limited. An advancement of the rectus externus on both sides may be advisable if a unilateral operation does not produce sufficient correction, or if abduction is weak on both sides, as happens not infrequently in alternating convergent strabismus. The extent of the second advancement depends naturally upon the degree of convergent squint remaining. That an over-correction is not to be feared, has already been mentioned.

With strabismus of *higher* degree, in which it is foreseen that neither tenotomy alone nor advancement alone will suffice, warning must again be given against a simultaneous performance of both operations. In such cases the patient should be told in advance that two operative procedures will be necessary to overcome the squint. The tenotomy is first performed, with supporting suture if necessary. The patient is then allowed to go about wearing fully correcting lenses for several weeks, by which time the final result of the operation will be manifest. The advancement may then be performed, the amount of advance varying with the degree of strabismus still existing. If, after the tenot-

omy, it is seen that the rectus internus may not be further weakened directly or indirectly by a strengthening of the antagonist, then the operation should be performed on the other eye. It would be worth the attempt to determine how far an advancement of the rectus externus could be influenced in a strengthening sense by a simultaneous partial tenotomy of the rectus internus, thus avoiding the danger of over-correction which accompanies tenotomy. The simultaneous performance of tenotomy and advancement should be reserved for the highest grades of convergent strabismus only, the advancement being performed with the foregoing precautions. This has also to be done in those cases of medium degrees in which we are compelled to correct the strabismus in one sitting, either through the request of the patien or for some other reason.

The advice relative to the operation for divergent strabismus is much simpler. The precept, which applies chiefly here, is to produce an over-correction; but this desideratum is not so easily attained. It must be remembered that advancement of the rectus internus is the only procedure, which has any material influence on a divergent strabismus. But in itself *an advancement of the rectus internus has not as much influence on the position of the eye as an advancement of the rectus externus.*

Two circumstances are responsible for this:

(1) On account of the local obstruction it is not possible to prepare and free as large a part of this muscle as in the case of the external rectus, and consequently the suture cannot be introduced as far back; (2) There is less room to advance the muscle, as the insertion of the tendon is normally near the limbus and cannot be brought much closer to it. In a similar way a division of the external rectus has much less influence on the position of the eye than a tenotomy of the internal rectus. As the tendon insertion of the rectus externus is already further removed from the limbus, its shifting by means of a tenotomy will cause relatively much less loss in the influence of the muscle on the motility of the eye, than is the case with the rectus internus. The value of the point of insertion grows in a rapidly increasing ratio as this point approaches the limbus.

From these observations it follows that, even in slight grades of divergent squint, both operations are usually performed simultaneously, in order to obtain immediately after the operation an over-correction—a slight degree of convergent strabismus—as experience has shown, that

there is always a tendency toward a return to the divergent position. A tenotomy alone of the rectus externus has hardly any influence. In higher grades of divergent strabismus even the simultaneous performance of both operations is not sufficient.

In such cases a **supporting suture** may be employed. This is introduced in a manner similar to that described for the counteracting suture in tenotomy of the rectus internus. Or a suture may be passed externally through the bulbar conjunctiva, not too close to the limbus, carrying both ends out through the palpebral fissure toward the median line. By drawing upon both ends firmly at the same time, the eye is brought into a pronounced convergent position, one end being drawn upward to the median line of the forehead, and the other over the bridge of the nose to the other side of that organ, in which positions both ends are fastened with several strips of plaster. A small piece of absorbent cotton is placed beneath the lower thread, so that it does not cut into the bridge of the nose. As the eye cannot be completely closed, it should be covered with a piece of oiled gutta-percha paper. The suture may be removed on the following day. The cornea will not be injured by the suture, especially if it has been introduced a short distance externally to the limbus, so that it raises a small fold of the conjunctiva.

If the divergent position is not yet corrected in spite of the supporting suture, then the analogous operation on the other eye is indicated.

If the divergent strabismus is the result of a tenotomy of the rectus internus that has been performed for convergent strabismus, then an **advancement of the rectus internus** usually produces an excellent result. The preparation of the muscle, however, is somewhat more difficult, as it is often inserted surprisingly far back from the limbus. It is scarcely possible, in such cases, to excise a part of the muscle, as there is only sufficient room to introduce the sutures. Nevertheless, the result is good, as the point of insertion can be brought forward a considerable distance. After an over-correction of convergent strabismus by tenotomy of the rectus internus, the operator must be warned against undertaking an advancement of this muscle within a few days after the tenotomy. The only course that can be pursued is to **introduce the counteracting suture.** An advancement according to exact rules is extraordinarily difficult, as the muscle can often be scarcely found in the congested and somewhat swollen tissue, and the procedure in addition is painful to the patient in spite of the cocain-

injection. Under these circumstances if the suture has not had the desired effect, it is much better to wait until the eye has recovered from its congested condition, and several weeks later undertake the advancement. An unsuccessful attempt at advancement may render the condition even worse.

Among the **unpleasant sequelæ** that may follow a tenotomy are **widening of the palpebral fissure, protrusion of the eye** and **retraction of the caruncle.** The last may occasionally be observed immediately after the performance of the tenotomy, and is due to fibers which pass from the rectus internus to the caruncle; these fibers become stretched through retraction of the muscle, thus exerting a traction on the caruncle, and causing its depression. Under these circumstances, the fibers should be divided by undermining the conjunctiva toward the caruncle with small clips of the scissors. This can also be done some time after the tenotomy, through a freshly made opening in the conjunctiva. An abnormal widening of the palpebral fissure should be remedied by tarsorrhaphy.

The principal indication for advancement of the rectus internus is manifest divergent squint, but it must also be performed in exophoria, in which **asthenopic symptoms,** such as fatigue and variable diplopia, arise even during use of the eyes at distance, provided, of course, that these symptoms cannot be remedied by the use of prisms. As the extreme correction possible from an advancement of the rectus internus is about 12 degrees, the operator must be governed in using this operation by the degree of **exophoria.** If the heterophoria is slight, the operation should be confined to a simple advancement without excision, or with excision of a short piece of the muscle. It is desirable that the patient should show immediately after the operation a slight convergence when looking into the distance. If binocular vision existed before the operation, the convergence will soon disappear under the influence of the fusion-tendency. When a carefully performed advancement of one internus does not relieve the patient of the exophoria and its accompanying symptoms, a similar advancement of the rectus internus of the other eye may be undertaken after the lapse of a few weeks.

In **paralytic squint,** operative interference should be resorted to only if it is decided that the paralysis is permanent and has been present for at least nine to twelve months. An effect upon the mobility of the eye can be promised from the advancement only in cases of partial paralysis of the muscle. In total paralysis no influence

can be exerted on the motility, and the operation is performed rather with the idea of returning the paralyzed eye to its normal position.

In general, all strabismus-operations have only a cosmetic value. It is only in rare cases that the operation for associated strabismus, restores binocular vision.

To secure a sufficiently good cosmetic result, the co-operation of the patient is needed not only during the operation (by remaining quiet, etc.), but also immediately afterward, when a rapid examination of the eye must be made in order to alter the effect if necessary, by means of supplementary procedures (sutures, etc.). It is better, therefore, to undertake the operation only in those patients who possess the necessary average intelligence for the different tasks assigned to them. Therefore, in our clinic we **operate only on children who have passed their twelfth or thirteenth year.** Before this period we confine ourselves to an accurate correction of refraction with the aid of atropin, to the constant use of glasses, and to the continuous exercise of the squinting eye by systematic bandaging of the healthy eye. When indicated, resort is made to regulated **stereoscopic practice.**

CHAPTER IX.

ENUCLEATION OF THE EYEBALL AND ITS SUBSTITUTES.

ENUCLEATION.

The greater number of the enucleations of the eyeball are made under general anesthesia. If, however, the eye is not markedly injected or tender to pressure, the operation may be performed under cocain-anesthesia. In the latter case one first thoroughly anesthetizes the conjunctival sac by instilling a 3 per cent. solution of cocain. The anesthesia may be better completed by adding several drops of adrenalin solution, which produces pallor of the eye and anemia of the conjunctiva.

The first step of the operation is to separate the conjunctiva from the eyeball. A fold of the bulbar conjunctiva is picked up with a pair of toothed forceps in the horizontal meridian near the limbus, and a small incision is made into it close to the limbus. Not a particle of conjunctiva should remain on the bulb, as every millimeter is of the greatest importance for the wearing of a prothesis.

The detachment of the conjunctiva is best performed in the following manner (Fig. 51): The blunt blade of the small, slightly curved scissors is inserted into the opening made near the limbus, and pushed forward beneath the neighboring conjunctiva, while the other blade remains in front of the cornea. The blades must be held parallel to the limbus. The scissors are then closed, thus separating the conjunctiva from its attachment at the limbus. This is continued, the conjunctiva being picked up with forceps at the end of the incision and the scissors being pushed forward until the conjunctiva is loosened completely at the limbus. As a right-handed operator always cuts from right to left, the detachment of the conjunctiva in the case of the right eye should begin on the inner side; in the case of the left eye, on the outer side of the corneal limbus. The lower periphery is separated first, and then the upper, so as not to be disturbed by the blood constantly running down. After the conjunctiva has been cut all the way around, it is undermined with closed scissors on all sides, in order to completely detach it from the eyeball.

The division of the straight eye-muscles is then made. The tendon of the internal rectus is the first muscle to be divided on the right eye; the tendon of the external rectus, on the left eye. The tendon is picked up with the toothed forceps in exactly the same manner as described under tenotomy (p. 84). While the assistant slightly lifts the conjunctiva in front of the muscle, the operator, having scissors ready in his right hand, pushes the shut forceps held in his left hand, along the sclera back, close to the attachment of the muscle, where

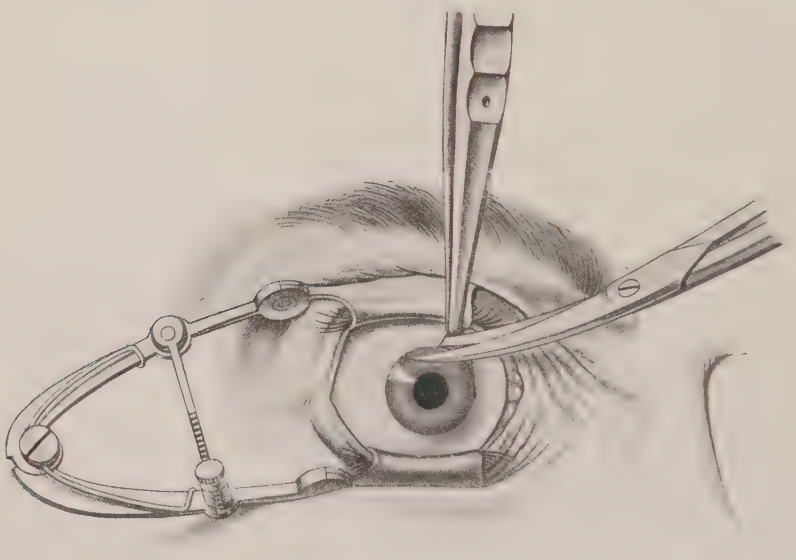

FIG. 51.—Enucleation of the right eye. Division of the conjunctiva has advanced to the vertical meridian. Note the position of the scissors: one of its blades is pushed forward beneath the conjunctiva, the forceps at the same time lifting the margin of the conjunctival wound somewhat; the other blade of the opened scissors is placed in front of the cornea in such a manner that by shutting the instrument the conjunctiva is separated close to the limbus.

he opens it and grasps the muscle by pressing the forceps against the sclera. The final detachment of the tendon from the sclera is not completed as in tenotomy; but the muscle is cut through at the side of the forceps, away from the eyeball, by pushing the blunt blade of the scissors under the muscle-tendon from beneath and cutting through it obliquely, so that a short piece remains attached to the eye, by which the globe is held during the subsequent stages of the operation (Fig. 52). By the tenotomy, Tenon's capsule is laid open, completely exposing the sclera. The small, slightly curved scissors, employed for the

division of the conjunctiva and the tendon, are now replaced by a somewhat larger and stronger pair, which may be either straight or slightly curved, the **enucleation-scissors.**

The eyeball, which is held throughout by the stump of the muscle-tendon, is rotated in a horizontal direction toward the side opposite the cut muscle (i. e. the right eye outward, and the left eye inward), and the scissors **inserted into the opening in Tenon's capsule,** which is found best by pressing the blunt blade of the opened scissors

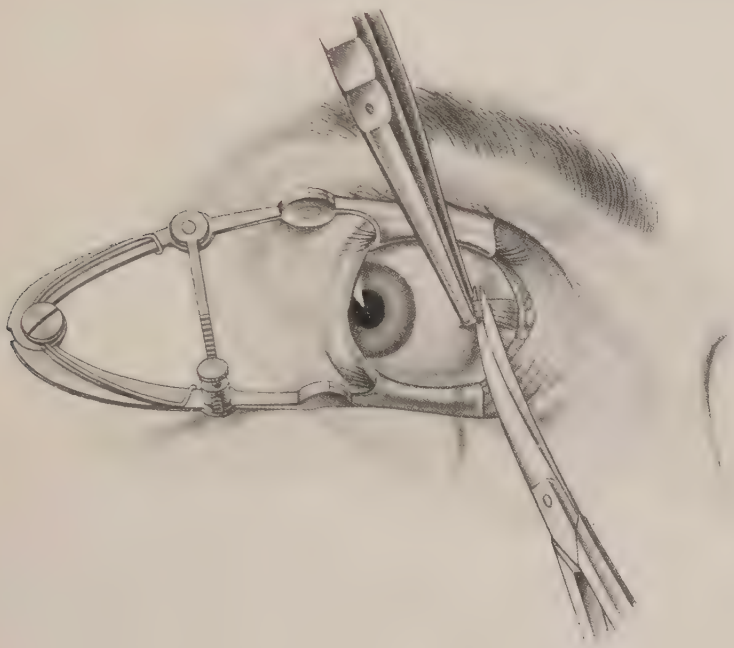

FIG. 52.—The forceps have grasped the internal rectus at its attachment, and have turned the eye outward; one blade of the scissors is pushed under the muscle to the inner side of the forceps to cut through it vertically to the direction of its fibres.

against the bared sclera and pushing it from here upward under the capsule. In this way the blade glides under the tendon of the **superior rectus** (Fig. 53). The muscle is recognized by the marked resistance which it offers the scissors. The eyeball is next pressed forward with the aid of the scissors, so that the tendon of the muscle is exposed, when it is cut off close to its insertion with one snip of the scissors. The tendon of the **inferior rectus** is next severed by similar fixation and position of the eyeball, excepting that the operating hand must be

held perpendicularly. In the same manner as before, the blunt blade of the scissors glides beneath the capsule of Tenon, lifts up the tendon of the inferior rectus, so it can be seen on the scissors, and cuts through it.

The tendon of the fourth straight eye-muscle is not divided until after the **severance of the optic nerve.** While the eyeball is held rotated to the right, the closed enucleation-scissors are pushed along the sclera slowly to the posterior pole of the eye (Fig. 54). Inasmuch as the optic nerve of the right eye is approached from the inner side, it is more easily reached than the left eye, where the advance is made

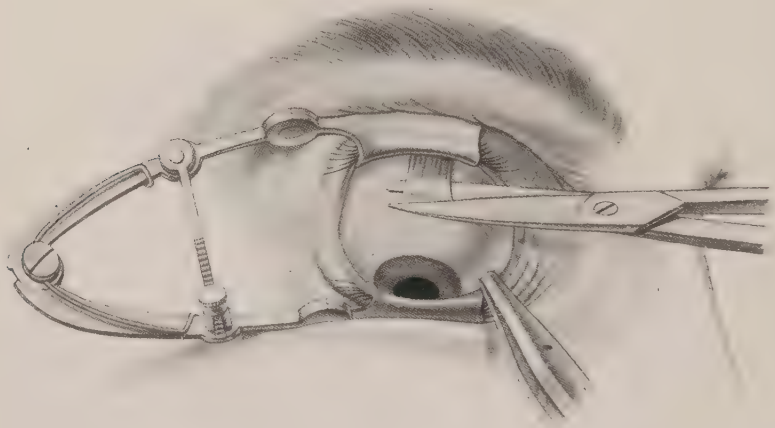

FIG. 53.—The forceps pull the eye downward with the tendinous stump of the rectus internus, while the blunt blade of the enucleation-scissors is pushed from the inner side under Tenon's capsule, until it reaches the superior rectus, which it now cut off close to its insertion.

from the outer side, and consequently the posterior pole must be passed before the nasal side of the bulb is reached. The beginner often has difficulty in locating the optic nerve. If the eyeball is rotated about its vertical axis to the right, and the closed scissors held to the horizontal meridian against the sclera, and moved from above downward, the optic nerve can be made out as a tightly stretched cord. The finding of the optic nerve may be facilitated by drawing the eye slightly out of the orbit in order to stretch the nerve. Ordinarily the nerve should be severed close to the bulb. After having ascertained its position, the scissors are opened, the operator feels around once more to make sure that the nerve is between the two blades, and then divides it with one

cut. The loosened bulb is immediately pressed forward with the closed scissors, and turned out from the orbit so that the assistant may check the bleeding with a tampon and prevent any suffusion into the orbit.

Nothing remains now except to free the bulb from its remaining attachments, which consist of the tendons of both **oblique muscles** and of the **fourth rectus,** and these are cut through with the scissors close to the bulb. If the enucleation has been properly performed, no large tissue-remnants should remain on the eyeball with the exception of the stump, by which the bulb is held. The wound in the conjunctiva

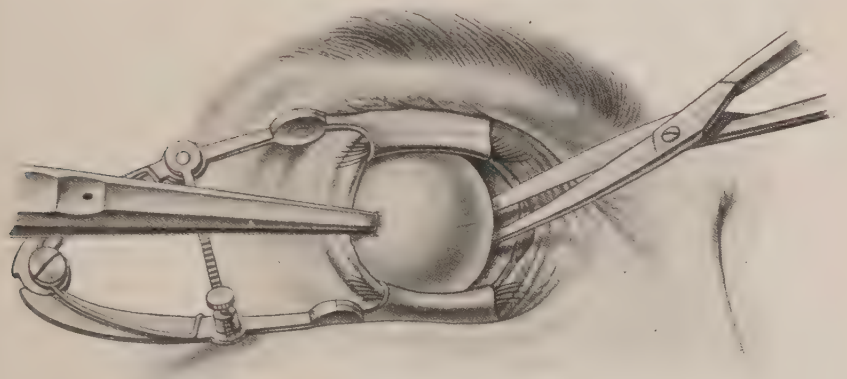

FIG. 54.—The eye, which is still held fast at the same point, is strongly turned outward exactly around its vertical meridian. The opened enucleation-scissors have the optic nerve between their blades ready to cut through it.

may be closed either with a purse-string suture or with several vertical sutures. If the latter are employed, it is important to draw both threads through near the border of the wound, so that no shortening of the conjunctival sac may be produced by the central margin of the conjunctiva projecting inward in the form of a roll. It is, however, **not at all necessary to close the conjunctiva with sutures.** It will, of itself, assume the best and most suitable position, and the wound will heal in a few days. Moderate compression should be employed in the dressing in order to prevent secondary hemorrhage. On the day after the operation the bandage is changed and a light pad worn for several days. The conjuntival sac is cleansed with a weak bichlorid solution.

If the operation is performed under **cocain-anesthesia,** the 3 per cent. solution is instilled into the conjunctival sac, and a 1 per cent.

solution (1 c.c.) injected beneath the conjunctiva by means of a syringe. The latter is inserted four times at the outer, inner, upper and lower portions. The conjunctiva is thus raised up in the form of a large bleb. The cutting may then be made without pain. Next follows a thorough undermining of the conjunctiva, in order that it may not interfere later during the removal of the eye. The muscle-tendons are then anesthetized by injecting $\frac{1}{4}$ c.c. of a 1 per cent. cocain-solution beneath the capsule of Tenon, immediately above each tendon. The point of the needle is placed in the direction of the muscle, and pressed close against the sclera. This produces a bleb-like bulging forward of Tenon's capsule, similar to that previously noticed in the conjunctiva. After lightly massaging the tissues, the division of the muscles should be proceeded with. To further lessen the possibility of pain, the muscle-tendons may be picked up with a strabismus-hook before parting them, and it is advisable at this time to cut off the fourth rectus so that the eye may be absolutely free as soon as the optic nerve has been severed.

The third injection is made into the neighborhood of the optic nerve after the division of the muscle-tendons. The syringe, containing a 1 per cent. solution of cocain, to which $\frac{1}{10}$ c.c. adrenalin has been added, is again used, and the solution slowly injected into the tissues about the nerve. After waiting for about one minute the optic nerve may be divided in the usual manner. It is not necessary that the syringe have a curved needle, as the nerve can be approached with a straight needle just as well.

Complications.—The enucleation does not always proceed as smoothly as described, and especially for the beginner is it no easy operation. Difficulties may be encountered even during the incision into the conjunctiva. If the eye had been inflammed for a long time, adhesions frequently exist between the conjunctiva and the sclera, and the separation may be troublesome. This is particularly the case if subconjunctival injections of solutions of mercuric chlorid or sodium chlorid have been repeatedly made, or, after injuries, destructive processes have led to cicatricial fusion between conjunctiva and sclera. The **loosening of the conjunctiva** becomes most difficult, sometimes even impossible, after the action of corrosives when, in place of a membrane, only a small layer of scar-tissue is found, which is thin and easily perforated. In any case the first consideration is to preserve the conjunctiva as much as possible, and not to tear it by unnecessary handling with the toothed forceps. The severing of the muscles

is made easier for the beginner if he searches for them with the **strabismus-hook.** The operator, however, who pushes the scissors beneath Tenon's capsule, after the manner described, finds that this method has the advantage of greater rapidity, but he must be careful while cutting the tendons of the superior and inferior recti not to injure the lid by a snip of the **scissors.** During the entire operation the lids must be held apart by a lid-speculum. By using Desmarres' lid-retractors an assistant is spared.

Should the **muscle-stump,** by means of which the eyeball is handled, break or tear off from repeated seizures with forceps new difficulties arise. If such an eye is soft, it is best to simply pick up a fold of the sclera in this neighborhood and in this way hold the eyeball or, when possible, grasp it by the remnants of the tendon of another muscle. When, however, they have been cut off perfectly smooth, the index and middle fingers of the left hand must be used to hold the bulb in the desired position in order to cut through the nerve. The closer to the eyeball the tendon is grasped and the less frequently the forceps are applied, the more firmly will the tendon hold.

The most difficult part of the operation for the beginner is the **division of the optic nerve.** If the knowledge of its position is acquired by slow groping about with the closed scissors, it will be almost impossible to miss it, but should the eye be incl,ned in an oblique direction, and the operator hastily make a cut anywhere backward in the orbit, he will not succeed in dividing the nerve. This blind cutting leads to a profuse hemorrhage into the orbit, which cannot be stopped by inserting a tampon, as long as the bulb remains in place. The infiltration may become so extensive that the tissue of the orbit is bulged forward like a tumor, and weeks may elapse before the blood will become absorbed. An attempt should be made to cut the optic nerve with the first stroke. **Injury to the levator palpebræ** can only occur, if the position in which the eyeball is held or the direction of the cutting, are extremely faulty. Cases of total ptosis, however, have been reported after enucleation.

After division of the optic nerve the eyeball must at once be displaced forward, so that the **tampon** may be inserted. It is unpleasant if the operator, instead of severing the nerve, cuts into the posterior part of the bulb itself. This may happen, if the eyeball is soft, following severe injuries which have induced a complete collapse of the bulb, or if the globe has ruptured when the muscles were severed. It is then

necessary to search for the nerve, while still holding the stump of the bulb, and resect it. As the surrounding orbital tissue becomes much swollen from effusion of blood, it is difficult to dissect and free the optic nerve so as to divide it further back. The bearings to its position are lost, and the profuse bleeding prevents a clear view.

Resection of the optic nerve must also be done, if, during enucleation because of a malignant growth, the stump of the nerve is found involved by the tumor. The nerve should be cut as far back of the bulb as possible; but if it is assuredly affected, exenteration of the orbit (p. 113) is a safer procedure than resection of the nerve. In iridocyclitis following injuries, in which sympathetic inflammation threatens, as much of the nerve as possible should be resected.

A rare complication after division of the optic nerve is severe, almost uncontrollable **hemorrhage** (arteriosclerosis, hemophilia). If energetic compression does not suffice to check the bleeding, ligation of the blood-vessels must be resorted to, or even the Paquelin cautery.

The main **indications for enucleation** are:

1. When the visual power of the eye is *irretrievably lost*, and the eye itself gives the patient *pain*.

2. When the sound eye is seriously endangered by a *sympathetic affection*.

3. *Malignant intraocular tumors*.

Therefore, *every painful amaurotic eye may be enucleated*. Enucleation of *still functionating* eyes must also be resorted to, as for example, when there is an intraocular tumor. If after an injury, an iridocyclitis develops and the outbreak of a sympathetic inflammation is feared, we do not have recourse to enucleation, so long as the eye retains good light-perception at six meters and has the proper light-projection. However, if both light-perception and projection have become greatly reduced, the enucleation must not be delayed, as we now have proof positive that the structures of the eye upon which the sight depends are becoming involved in the inflammatory process, and that the visual power is being destroyed for ever. After recent injuries, enucleation should not be deferred when there is no doubt that vision is lost. *Extensive ruptures of the cornea and sclera* with prolapse of the iris and crystalline lens justify immediate removal of the globe. Prompt action spares the patient weeks and months of suffering. After great injuries one may suture the gaping wound before the enucleation, so as to make a squeezing-out of the ocular contents impossible.

Ruptures of the sclera furnish the indication for enucleation much less frequently. Even though the visual power is usually either entirely ruined or returns only to a minimum extent, still such eyes can later become absolutely quiescent, and often do not seem to be materially disfigured. Not until the rupture of the sclera is followed by a shrinking of the globe, and this being eventually associated with pain and injection, should enucleation be performed, but then, however, without delay. Justification for enucleation must not be considered as existing simply because the light-perception of the eye is completely destroyed after a trauma. Not infrequently it happens, that immediately after a blunt trauma the light-perception is completely lost, but both perception and projection return gradually and within a certain time may even reach normal. We have seen such eyes, which, from a condition of absolute amaurosis, (rupture of the sclera, with hemorrhage and obscuration of the lens) have regained partial visual acuity.

Enucleation is practised on eyeballs with a high degree of **ectasia** (total staphyloma of the cornea, and staphyloma of the sclera), which are disfiguring because of their size, and are in danger of rupture, resulting in serious hemorrhage. Enucleation is indicated when **panophthalmitis** is developing. For example, if, after an injury which in itself was not considered sufficient indication to perform an enucleation, the eyeball becomes infected, and this infection is rapidly progressive and through its intensity makes a panophthalmitis probable, we check the process by enucleation of the eyeball. Enucleation is also demanded if the eye becomes seriously infected after operative interference, as, for instance, a cataract-operation. If, however, the panophthalmitis has already developed, that is, if exophthalmos, marked edema of the lids, limitations of the movements of the eyeball, chemosis, etc., are already present, enucleation is contraindicated, as experience has shown repeatedly that meningitis may follow the operation. The proper procedure in such cases is to open the anterior portion of the eyeball to permit the free drainage of the pus and thus furnish the patient relief.

EVISCERATION OF THE EYEBALL.

Evisceration of the bulb with sewing in of **glass balls** or **gold balls,** etc. (**Mules's operation**) is not performed at our clinic. Cases of sympathetic inflammation have repeatedly been observed after this operation, not only by us, but also by others. The expulsion of the sewed-in balls occurs frequently, and sometimes even after years have

passed. This may be accompanied by symptoms of inflammation, which may require operative interference, such as the shelling out of the balls; in fact, subsequent enucleation of the stump may be necessary.

OPTICO-CILIARY NEUROTOMY.

Optico-ciliary neurotomy is a substiute operation for enucleation of the bulb. If an eye blinded by glaucoma has become painful, a certain indication for enucleation exists. But in case this eye is not disfiguring, it is more desirable that the owner retain it than replace it with an artificial eye, the use of which is associated with many inconveniences. Such eyes, therefore, furnish the suitable indication for optico-ciliary neurotomy. Rarely do we use it if the eye has become blind through a spontaneous irido-cyclitis—one not induced by injury—and causing the patient pain. In these cases the eyes for the most part are shrunken and disfiguring, so that enucleation must be recommended on cosmetic grounds alone. If an injury has preceded, enucleation must of necessity be performed, as an optico-ciliary neurotomy would not prevent a sympathetic inflammation. When the slightest suspicion of an intraocular tumor exists, that enucleation is peremptory in every case, needs no further explanation.

The operation is done under general anesthesia. It is begun by freeing the rectus internus if in the right eye and the rectus externus if in the left eye, as in an operation for advancement. A suture is passed through the muscle at a distance of about $\frac{3}{4}$ cm. from its attachment, then tied, and given to the assistant to hold, after which the muscle is divided between its insertion and the knot. The assistant now pulls the muscle away from the eye by means of the suture, the operator using the stump, which remains attached to the eye, to fix the bulb. As in enucleation, we now pass slowly backward along the sclera with the enucleation-scissors, and feel around for the optic nerve, take it between the two blades of the scissors and glide backward along it for a short distance. With one vigorous snip it is divided. The scissors are withdrawn at once and strong pressure maintained on the bulb through the closed lids for five minutes to prevent a hemorrhage into the orbit. Without this compression it may happen, that the loose eye is pushed through the palpebral fissure at once, or it may be found out of the orbit on the next day. As a reposition is impossible, nothing remains but enucleation. But this complication may also occur in spite of a perfect compression, as in the aged, who chiefly undergo this

operation, arteriosclerosis may be the cause of such an extensive hemorrhage.

As it is obvious that we have not divided all the ciliary nerves (transmitters of the pain) with the one cut, we now turn the eye about its vertical axis in such a manner, that the posterior surface of the eyeball lies free in the palpebral fissure, and are thus enabled to readily cut the ciliary nerves that pass through the sclera in the neighborhood of the optic nerve, the greater number of which have already been torn during the turning of the eyeball. If a long piece of the optic nerve remains attached on the eyeball, a part of it may be resected (neurectomy). After this the eyeball is replaced in its normal position, and the muscle carefully sutured to the stump to insure its normal motility. After sewing the conjunctiva, a firm pressure-bandage is applied over the closed lids. Usually, healing progresses without incident. The slight amount of exophthalmos after the operation, because of the hemorrhage, disappears within a short time.

If the operation has been performed according to these directions, the cornea is perfectly anesthetic and the eyeball free from pain. The sensitiveness of the cornea returns very slowly. A neuroparalytic keratitis is not to be feared. Over the fundus the blood-vessels are seen to be absolutely empty, appearing as white lines, and the papilla is a pure white. The tension of the bulb remains normal, sometimes even greater than normal. Atrophy of the eyeball does not develop.

EXENTERATION OF THE ORBITAL CAVITY.

Exenteratio orbitæ, the removal of all the contents of the orbit for the extirpation of malignant neoplasms, whether of the orbit itself or of the eyeball after they have broken through the sclera, is performed as follows:

If the lids are to be preserved, the palpebral fissure must first be widened by **canthotomy**; this exposes the outer border of the orbit. Next, the conjunctiva of the lower fornix is cut through with a sharp scalpel to the bony lower border of the orbit, which is thus completely bared. The assistant draws the lid away with a dull tenaculum. The upper conjunctival fornix is then cut through in the same manner, along the upper orbital margin. To the inner side both incisions meet at the front part of the lachrymal bone. Both lids can now be easily drawn away from each other with tenacula, so that the entire orbital border is exposed. The periosteum is incised along the bony margin

of the orbit, and by means of a periosteal elevator or a closed, somewhat curved, scissors, pushed between bone and periosteum, the entire contents of the orbit are shelled out with great rapidity on all sides to the posterior end of the orbit. Only at the inferior orbital fissure and at the posterior crest need we make use of the scissors to divide the fascial strands. With proper care we can easily avoid injuring the thin bones of the orbit. Finally the entire mass is divided as far back as possible by several snips of the scissors. Energetic tamponing prevents serious hemorrhage, for the checking of which we are rarely forced to use the cautery. The orbital cavity is now tightly packed, gauze is pushed beneath the lids so that they will not fall into the orbit, and a pressure-dressing applied. At the outset a long time ensues before the wound of the orbit begins to be covered with granulations, and several weeks pass before the entire cavity has become filled with granulations. During this time it must be kept loosely packed.

In the end, however, the lid is always drawn far back by scar-tissue, and the use of an artificial eye is not possible. The palpebral conjunctiva may even become a burden to the patient on account of its secretion and, therefore, nothing is lost, if in the exenteration of the orbit the lids are also cut out. Such an operation is easier, and the large wound in the skin can be so diminished by a few vertical sutures that only the normal width of the palpebral fissure remains.

CHAPTER X.

PLASTIC OPERATIONS WITH PEDICLED FLAPS ON THE EYELIDS.

Plastic operations with pedicled flaps are particularly adapted to those cases in which a lid affected with a neoplasm must be excised.

As long as a new-growth in the lids has merely involved the skin, and the tarsus is wholly preserved, the plastic operation with a pedicled flap from the surrounding tissue differs in no respect from the identical operation in other regions of the body.

The method of Fricke is used in case of an extensive skin-defect (*d*) in either the upper or lower lid. A flap is taken from the neighboring skin, as is shown in the illustration (Fig. 55) and the base joined to the defect in the tissue. Because of possible retraction of the skin after it has been dissected free, the flap (*f*) must be cut about one-third larger than the area to be covered, and the base wide enough to insure perfect nutrition. For the same purpose, rotation of the flap should be made as easy as possible by an adequate undermining of the underlying tissues. The flap, which now covers the excised area, is held in its new position by sutures. The opening, caused by the removal of the flap, is dissected sufficiently back of the margins, and the skin-edges brought together, at least in part, by sutures, the remainder being left to heal by granulation; or the wound is covered by transplanting epidermis, according to the method of Thiersch, or by a small non-pedicled flap. The bulging at the base of the flap produced by the necessary rotation soon disappears, so that no subsequent disfigurement exists.

If, however, the margin of the lid has already been involved, as is usually the case, since new-growths spring more particularly from the lid-margin, the restoration of the lid becomes a more difficult matter.

The method of Dieffenbach is the typical one for the lower lid. As a recurrence of a lid-neoplasm is only prevented by cutting at least a full half-centimeter away from the growth, a large part of the lid must be sacrificed even if the tumor is not extensive, and, if large, the whole lid must be excised. There is very little advantage in retaining the

small remnants of the lid left at either end of the incision, and the operation is not rendered more difficult by a total extirpation of the lid. The tear-ducts are to be spared only if they lie beyond the field of operation.

In Dieffenbach's method, the wound has to be brought in a triangular form. The base of the triangle corresponds to the lid-border (*bc*) (Fig. 56). In the direction of the base an incision (*ab*) is performed outward toward the temple, somewhat larger than the defect

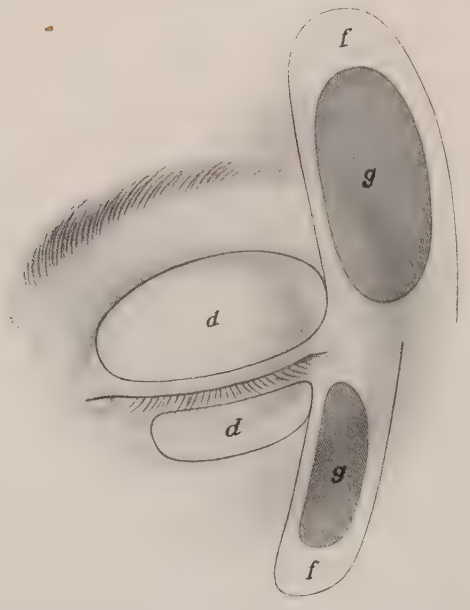

FIG. 55.—Restoration of a skin-defect in the upper and lower lid (after Fricke). d, defect; g, pattern of guttapercha paper, cut the same size as the defect, and laid on the place selected before excision of the flap, in order to estimate more readily the size of the latter; f, flap to be cut out.

to be repaired, as the flap contracts after it is freed. From the outer end of this incision, another cut is carried downward, parallel to the outer side of the triangle. A flap can now be dissected off, the base of which lies below. Sufficient freeing from the underlying tissue affords easy rotation inward upon the defect. The upper edge of the flap is sutured to the remains of the conjunctiva, and corresponds to the lid-margin, while the inner edge is secured to the neighboring skin by strong sutures. The surface from which the flap was taken is closed in as much as possible by sutures after a thorough under-

mining of its edges. The remainder of the exposed area is left to heal by granulation.

The results produced by this method of operation are only moderately satisfactory. The diseased area is, it is true, covered in by healthy skin, but as the flap, lacking a cartilaginous substratum, is yielding, it sinks downward continuously, and becomes drawn against the eyeball and attached directly to it by the cicatrix. The conjunctiva is also materially shortened, the movability of the eyeball is usually considerably lessened, and besides, the hairs continuing to grow from the skin of the flap, in a short time cause a clouding of the lower half of the cornea.

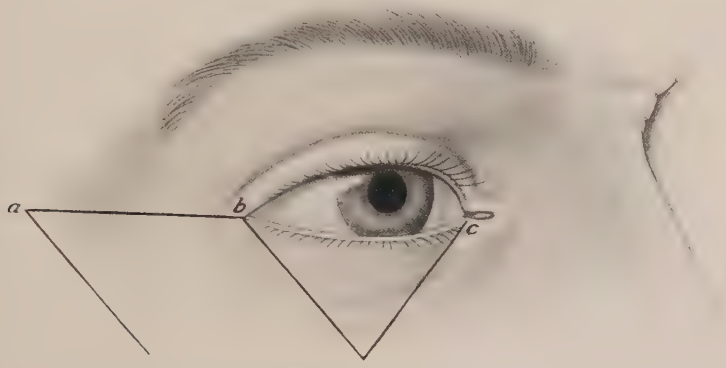

FIG. 56.—Restoration of a lower lid after Dieffenbach. The lower lid is excised in triangular fashion; that is, a pre-existing defect is brought into this form. Formation of a quadrangular skin flap (a b), which is freed from its underlying tissues.

The combination of Dieffenbach's method with the plastic operation making use of the ear-cartilage, as first recommended by **Buediner,** represents an extraordinary advance in the treatment of such cases.

After the skin-flap has been freed as in the foregoing description, a flap, including not only the skin but also the cartilage, is excised from the posterior surface of the ear. It should be as long as the lower lid, have a straight edge corresponding to the lid-margin, and a second somewhat convex edge corresponding to the lower border of the tarsus. Because of the narrowness of the normal tarsus of the lower lid, we need only take a very small piece of cartilage from the ear. On the contrary, to cover the wound-surface we must take a much larger piece of skin. There is first made a vertical incision of adequate length

on the posterior surface of the ear. This will at once retract somewhat, and at the point of retraction an incision is made through the cartilage, corresponding to the length of the tarsus. This edge of the flap forms the new lid-margin. Next the dissection is continued 3 mm. further beneath the cartilage, that is, between cartilage and skin of the anterior surface of the ear, and the cartilage is cut through from in front without wounding the skin. In order to free the skin, it is dissected an additional 5 mm. with a slightly convex incision. In consequence, the freed flap shows the shape viewed from the raw surface (Fig. 57).

As the ear-cartilage is too thick, it is shaved down by cutting away thin lamellæ with a scalpel applied flatwise, until it approximately equals the thickness of a normal tarsus. This flap is fastened by sutures to the previously dissected skin-flap (Fig. 58), so that the wound-surfaces are apposed to each other; that is, the skin of the ear-flap is directed posteriorly toward the eyeball and the straight edge comes to lie against the free upper margin (*ab*) of the pedicled skin-flap. In order to avoid unsightly indentations of the new lid-margin by pressure of the sutures, we employ sutures armed with two needles. Both ends are pushed from behind forward through the skin and the cartilage, 2 mm. below the free margin. They are tied over a glass bead. At least three sutures are necessary. In like manner one or two sutures are brought through the lower border of the skin- and cartilage-flap in an anterior direction and tied, in order to secure a firm approximation of the flap to its new base.

FIG. 57.—Flap from the posterior surface of the ear; c., cartilage; w. s., skin seen from the wound-surface.

The pedicled flap, with its posterior surface thus provided with a sufficiently large cutaneous surface, is sutured after adequate rotation, to the edges of the defect, as in Dieffenbach's original method. To prevent mechanical injury to the cornea by the flap, which is somewhat stiff at first and readily produces erosions and ulcers, I am accustomed to draw the upper lid far downward by two stiches passing through its margin, and to bring both ends of each suture through the base of the flap, which has been rotated inward; not until then is the flap fastened to its new position. Thus the new lower lid lies at first against the upper lid. The defect produced externally is covered in exactly the manner described by Dieffenbach. The flap of skin and cartilage heals in promptly. Both eyes are bandaged and the dressing

changed for the first time after two days. The fixation-sutures of the upper lid, which were tied over small gauze pads, are allowed to remain as long as they hold. They cut through in from five to six days. However, the upper lid continues to hang down for several days more, completely covering the cornea, but by the time it can be elevated, the flap of skin and cartilage have long since healed, and in its moist environment the skin has become so delicate that an injury to the cornea need no longer be feared.

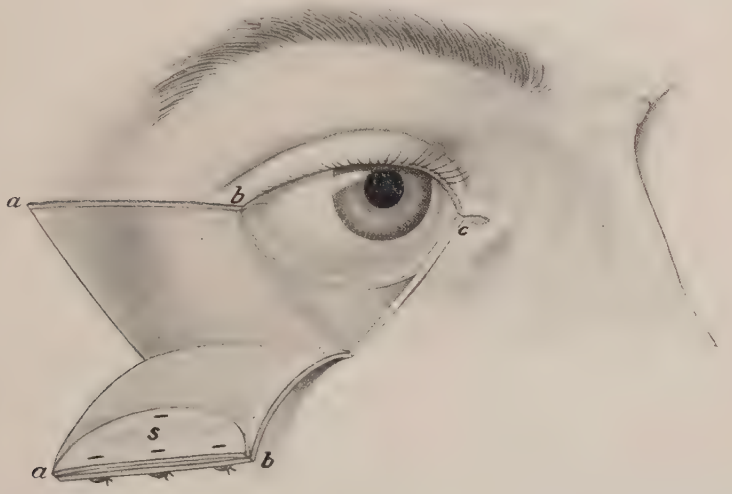

FIG. 58.—The flap represented in Figure 57 is here so sutured to the posterior side (that is, the raw surface) of the pedicled skin flap that the skin (s) comes to lie posteriorly toward the eye. The flap is now twisted into the defect of the lid and sutured in such a fashion that (b) comes to lie in apposition to c and a of the flap in apposition to b of the canthus.

The flap, which at first seemed too thick and bulging for a lower lid, later becomes gradually thinner. It resembles quite well a lower lid deprived of its eyelashes, especially as it stands up freely owing to its cartilaginous substratum, and is not drawn against the eyeball through the formation of a cicatrix. This method is particularly valuable, because the motility of the eyeball remains unaffected, and a deep conjunctival sac is created, similar to the normal. Furthermore, the transplanted flap, free of hairs, does not give rise to corneal irritation. These are sufficient reasons, to undertake Dieffenbach's method only with the proposed modification.

If the entire upper lid must be extirpated in the removal of a neo-

plasm, the eye is usually lost; but an attempt should be made to restore the upper lid by a flap, which is formed according to Fricke's method, its posterior surface being covered in by a delicate layer of epithelium taken from the arm.

OPERATIONS FOR SYMBLEPHARON.

If the connection between the conjunctival surface of the lid and the eyeball is in the form of **isolated bands,** which interfere with the movements of the eye and produce diplopia, an indication for their division exists in every instance. The separation of the cicatricial strands must be followed by a closure of the resulting wound, in order to prevent the two raw surfaces from again growing together. In the case of small strands, closely-applied sutures will usually be sufficient. The neighboring conjunctiva must, however, be loosened so that the sutures may draw it over the defect; incisions in the surrounding tissue to relieve tension are of considerable value.

If more of the conjunctival sac is affected, that is, if the symblepharon is broader, there will not be enough mucous membrane to draw over and to cover the defect. In this event it is necessary to dissect either a pedicled flap from the conjunctiva of the neighborhood, or a flap without pedicle from a suitable point, usually the upper conjunctival fold, or it may be taken from the conjunctiva of the patient's sound eye.

The greater number of the symblepharon-operations are required to the lower lid. If a symblepharon involving the lower internal portion of the conjunctiva has been divided, and on account of the size of the defect a **plastic operation** is indicated, it is possible to take a pedicled flap from the adjacent conjunctiva and cover the defect by rotating it over the wound and fastening it there by means of sutures. The new defect produced by the excision of the flap may be allowed to cicatrize, as, lying to the outer side of the wound in the lid, it does not give rise to new adhesions; or the defect may be covered, as well as possible, by loosening of the neighboring structures and sutures.

The formation of pedicle flaps is, however, in most instances difficult, and it is, therefore, preferable to cover in the defect in the conjunctiva of the eyeball with a flap taken from the upper conjunctival fold. The flap is held in its new position by several delicate silk sutures. Naturally, the removal of this flap is only possible when the conjunctiva of this fold shows no cicatricial changes. The normal

fold offers ample conjunctiva for broad flaps, but, if contracted, the flap may be taken from the patient's other eye, provided, of course, that it is normal; this gives the greatest chances of satisfactory healing.

From personal experience it may be stated, that all similar proceedings with **mucous membrane from a rabbit** are to be completely rejected. Even if the graft is successful, which is much more uncertain than when human conjunctiva is employed, the animal mucous membrane subsequently contracts so greatly that the good effect produced is entirely lost.

In all methods of covering the defects with conjunctiva, we must be content to do so over only one of the wounds, as flaps large enough for the wound in the eyelid cannot be obtained. Though the covering of the one defect is sufficient in most cases, it is always better to have both wounds provided with epithelium, not only to prevent the formation of a new symblepharon in case the single flap does not heal in properly, but because the scar arising from the uncovered wound may contract later on and gradually draw the lid inward and cause trichiasis; or result in limitation of motion of the eyeball. For the foregoing reasons many plastic methods have been devised, intended to cover the wound in the lid. The various methods, as in all plastic operations, consist either in applying a pedicled flap from the neighboring skin or a free flap of epidermis.

In cases of **complete symblepharon** of the lower lid the repair of the lid-wound is especially imperative. The defect on the eyeball is too large to be covered in its entirety by conjunctiva taken from other places. We have repeatedly employed in these cases a combination of conjunctival and skin-flap with good results. After thoroughly dividing the scar and covering the wound on the eyeball with a pedicled flap taken from the upper conjunctival fold, the wound in the lid should be covered by a skin-flap, which, following **Rogman's method,** may be taken from the lower lid itself. From the skin of the lower lid (Fig. 59) a flap (*abcd*) is made, the base (*ad*) of which is situated directly at the upper level of the conjunctival fold in need of reconstruction. This flap is as long and as high as the lid. Next, an incision beginning at the lower level of the conjunctival fold and corresponding to the line (*ad*), divides all the structures in such a manner as to leave only the skin intact. It is then an easy matter to rotate the flap in through the slit so made. This should be done so that its raw surface is turned toward the wound in the lid, and the

margin (*bc*) of the flap may be fastened with sutures to the margin of the lid. The flap is certain to become attached, as its base remains connected to the surrounding tissues. The wound on the outside of the lid is, as far as possible, tied by sutures. At first, however, there is a slit left through which the new conjunctival sac can be reached from the outer side. After about eight days, the connection is severed; the slit now rapidly closes through cicatrization. Rogman, in his original method, repeated this procedure at a later date by rotating through the slit another flap formed from the still remaining skin on

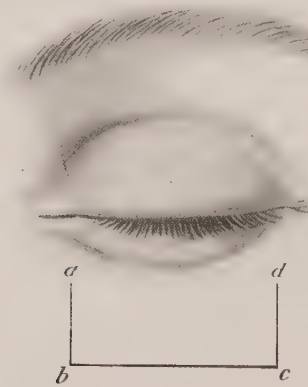

FIG. 59.—Operation for symblepharon after Rogman. After separation of the symblepharon between the eyeball and the lower lid, there is formed from the skin of the lower lid the flap (a b c d); it has its base at a d. This flap is rotated backward through a slit in such a fashion that the edge (b c) can be sutured to the palpebral margin and the skin—serving the function of a palpebral conjunctiva—is turned toward the eyeball. There is rotation of 180°.

the lower lid. I much prefer the foregoing combination to Rogman's original method, as there is too little skin available for the second plastic operation on the lid.

The best method to thoroughly remove a total symblepharon is as follows: The scar is divided as in the other methods by means of a scalpel, and an external canthoplasty performed. From the end of the skin-incision, a cut 3 cm. long is made outward and downward. From this point on, the skin is dissected off toward the lid, until finally the entire lower lid can be reflected toward the nose as a free flap. The dissection must be carried beyond the scar-area into the healthy tissue, so that, finally, there is a large raw surface which stretches in one plane from the limbus to the lid-border. After this, a large skin-flap of a suitable shape is dissected from the delicate skin

of the upper arm, according to the rules already mentioned (see Cicatricial Ectropion, p. 52), and fitted accurately to the raw surface up to the palpebral fissure. The flap may be sewed with several fine sutures to the lid-margin on the one side, and to the limbus on the other. As the lid is now turned back again into its original position, the flap folds up properly of itself, the place doubled down representing the new fornix. In order to fix the fold in this position, two sutures are carried through from this spot out to the cutaneous surface, and their ends tied outside over gauze. The operation is completed by the suturing of the incisions made at the beginning. Both eyes are bandaged and **the dressing** changed for the first time at the end of three days.

The fornix is at first adnormally deep, but, later, diminishes in size through contraction, without, however, shrinking so much as to prevent free movement of the eye on the comfortable wearing of a prothesis. In these cases we must begin to insert a prothesis quite early, and to make eventually properly fitting protheses from Stent's composition, a substance used by dentists for taking impressions. Such protheses extend deeply down into the fornix.

Insertion of an unpedicled flap without making the incision proposed is not recommended, as the limited space makes the operation more difficult, and an adequate adaptation of the flap is impossible. It is only by accident that such a flap heals in properly. Likewise, the same can be said about the proposition of laying the unpedicled flap over the prosthesis in such fashion that its epithelial surface is turned toward the latter, the prothesis with this covering being inserted after cutting through the scar.

CHAPTER XI.

EXTRACTION OF SENILE CATARACT.

The accompanying illustrations have all been made from photographic views, and are intended, primarily, to reproduce faithfully the position of the hands of the operator as well as those of his assistant during the different operative procedures. This can be accomplished better by a picture (especially a photograph) than by the most extensive description. In so far as possible, the operative procedure on the eye itself is also delineated sufficiently well in the same illustration. However, when it seemed necessary, the operation on the eye has been represented by itself in accompanying diagrams. The photographs were taken from the operator's side. In order to render recognition easier, the hands of the operator are indicated by the latter *o;* those of the assistant, by the letter *a.* In all instances the operator sits to the right of the patient, while the assistant stands to the left. The relative positions assumed by the hands and the fingers of the operator and assistant should be observed. The figures show clearly how the hands are supported, how the instruments are held, etc.

TECHNIC.

The technic of the various steps of the operation will first be considered, and then the complications which may occur in each of these steps.

1. **Fixation of the Eye** (Figs. 60 and 61).—It is best to sit at the right of the patient who is lying upon the operating table. The incision is made from the outer side, on the right eye with the left hand, and on the left eye with the right hand, the other hand being engaged in the fixation of the eyeball. For this purpose an ordinary pair of toothed **fixation forceps** with three dentations is held between the thumb and forefinger. The forceps must be applied perpendicularly to the sclera and quite near the limbus, so as to get hold of a tight fold of the conjunctiva. If the conjunctiva is seized at even a slight distance from the limbus, the fold picked up is so loose that the eye is not sufficiently fixed. During the cataract-incision the forceps

at the lower part of the limbus grasps the eye exactly in its vertical meridian. The operator at the right of the patient finds no difficulty in fixation of the right eye, as the forceps held in the right hand are placed directly opposite to the right eye, but it is not so easy, especially for the beginner, to fix the left eye from the position mentioned. To this end the left upper arm, with the elbow in a strongly flexed position,

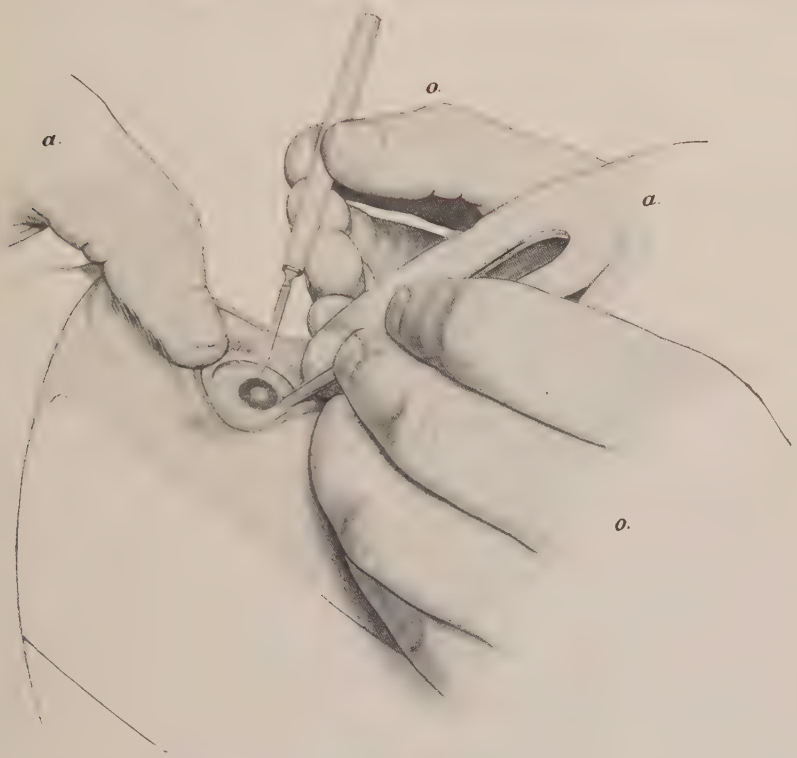

FIG. 60.—Beginning of the cataract-incision in the left eye. While the assistant holds the eye open according to the rules given on page 236, the forceps held in the left hand grasp the eye below, close to the limbus and exactly in the vertical meridian. The patient during this procedure looks well downward. The knife held in the right hand with its edge directed upward is applied exactly at the limbus and is held horizontal and parallel to the plane of the iris.

is pressed firmly against the chest, while the hand, itself bent dorsally, guides the forceps held between thumb and forefinger, vertically to the lower portion of the limbus, where the fold is raised. Through this unaccustomed position of the arm, the beginner very easily falls into the error of pressing upon the eye instead of pulling forward, a mistake that is frequently the cause of unpleasant complications.

The fold of the conjunctiva must be raised exactly in the vertical meridian. Since the operation is performed in most cases with an iridectomy, it is essential that the incision be made accurately above, so that the coloboma, which corresponds to the central portion of the cut, will also be directed upward, and be completely covered by the upper lid. If, however, the eyeball is grasped sideways, for example,

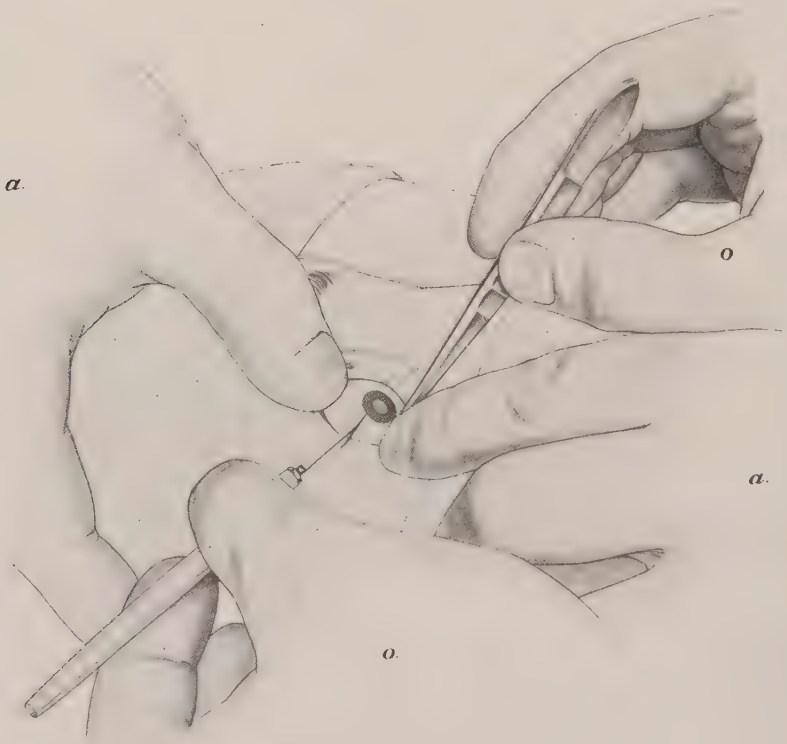

FIG. 61.—Beginning of the cataract-incision in the right eye, the operator and the assistant occupying the same position. The eye is fixed with the right hand, the knife is held in the left.

at the end of the horizontal meridian, a rotation of the eye is unavoidable, as the eye must be drawn continually downward during the incision, in order to expose the upper corneal margin. In consequence of this rotation the incision is placed in an oblique and undesirable position, and with it also the coloboma. If the eye is fixed below, exactly in the vertical meridian, there ensues no rotation, so that no mistake can be made concerning the situation of the incision. In

inserting the knife, it is true that the eye may rotate slightly out of its position, but this can not further displace the incision. By means of the elevated fold the eye is drawn not merely downward, but also slightly forward. During the incision the patient is directed to look well downward.

2. **The incision** (Figs. 60 to 64) is probably the most difficult part of the operation and demands the most detailed description. It is made with the narrow **Graefe cataract-knife.** It is executed in an upward direction, should include about one-third of the corneal

FIG. 62.—Diagram showing the point of the knife directed toward a point in the cornea about 1 mm. within the limbus, so as to begin the counterpuncture.

periphery, and in its entire length should run in the limbus or close behind it.

While **inserting the knife** its point is placed on the limbus externally 1–2 mm. above the end of the horizontal meridian, while it is held horizontally between the thumb and first and second fingers. Meanwhile, the hand is supported by the little finger placed on the patient's head (Figs. 60 and 61). The edge of the knife is directed upward and the blade is parallel to the surface of the iris. The point of the knife pierces the eye at the limbus, and is pushed without a pause

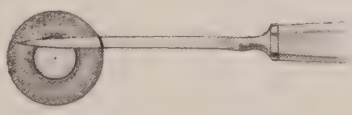

FIG. 63.—Diagram showing the point of the knife thrust just through at the limbus.

through the anterior chamber in order that the counteropening internally is made in a symmetrical position. Here it should be emphasized that the chief factor in the success of an incision, which is to open the anterior chamber, is the **avoidance of any pause or retrograde movement.**

The most difficult point for beginners is to make the **counter puncture** in the proper position. To their astonishment, most novices find the knife emerging in the sclera behind the limbus. The reason for this error is clearly understood from a study of the anatomical relations of the anterior chamber (Figs. 62 and 63). The limbus extends much

further (2 mm.) anteriorly than the angle of the anterior chamber. If the knife is brought as far as this angle, the inevitable consequence is that the counterpuncture is performed in a faulty place far beyond the limbus. In order that it is made either directly at the limbus, or close to it, the knife must be directed to a point in the cornea about 1 mm. from the limbus, where, as viewed from in front, transparent cornea is still present. The impression thus given is that the knife will appear at the surface in transparent cornea, but to the operator's surprise the point emerges in the limbus. The beginner is, therefore, usually told to direct the point of the knife toward a spot in the cornea, situated about 1 mm. distant from the limbus.

After completing the counterpuncture the knife is steadily carried upward in sawing movements, at all sides parallel to the limbus. This procedure is somewhat troublesome for the beginner, as he must cut away from himself in a manner to which he is not accustomed. A keen-edged knife readily passes through the tunics of the eye, so that the incision can be completed in two or three drawing motions. Short sawing motions must be avoided, as they produce an irregular wound. The reason that the beginner frequently does not advance the knife, in spite of many short sawing movements, lies usually in the fact that instead of pushing the edge upward, he presses the knife backward toward the sclera.

After completion of the counterpuncture, the *incision should be continued without delay*, in order to pass smoothly over the pupillary margin before evacuation of the aqueous humor. If the completion of the incision is delayed, the anterior chamber is abolished and the iris falls in the way of the knife, and is unavoidably injured. To pause after the counterpuncture, however, is a very common error with beginners. If properly executed, the sawing movements, claimed by many to be so disadvantageous, cause no inconvenience whatever. In this way with a keen-edged knife the incision may be completed in two movements by sawing sections just as well as when it is performed by elevating and lowering the handle of the knife.

During the incision *the knife must remain exactly parallel to the iris*, as any turning of the edge forward or backward would naturally result in a deviation of the cut, either into the cornea or into the sclera. Only after cutting through the outer tunic of the eye, and the knife is seen under the conjunctiva, is it recommended to turn the blade through an arc of 90 degrees (Fig. 64), so that the edge looks anteriorly.

This secures a conjunctival flap that is much shorter than if the knife in the previous position had been permitted to cut through. A long conjunctival flap is an unpleasant impediment to a proper per-

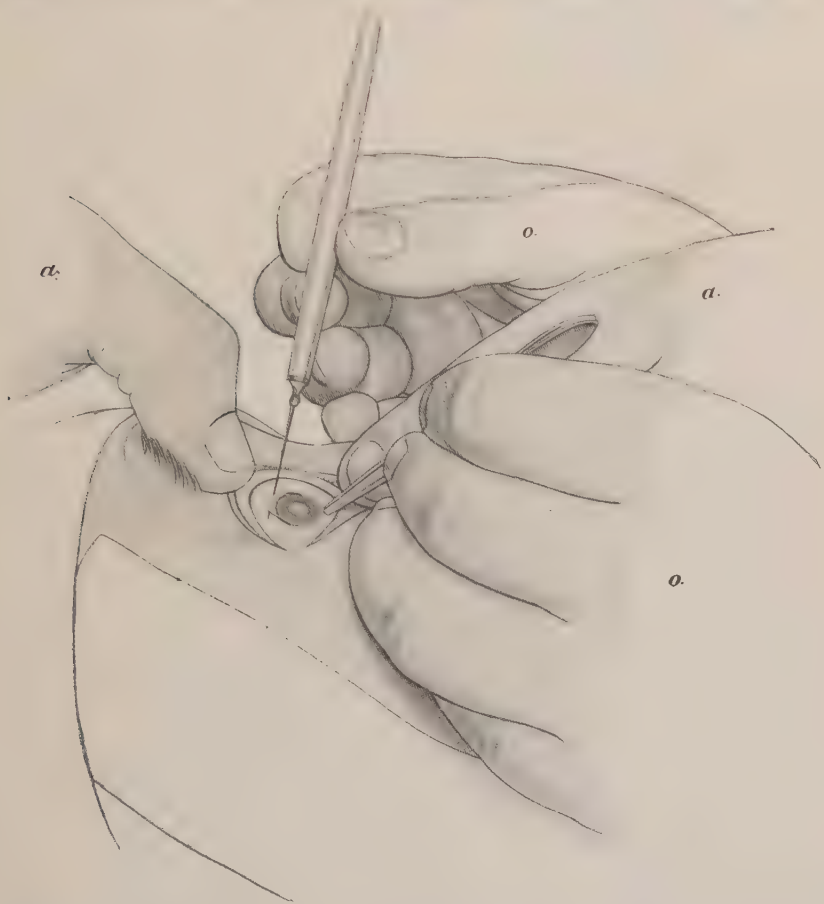

FIG. 64.—In this illustration the incision has advanced so far, that the cornea-sclera is already cut through and the knife is beneath the conjunctiva. In order to cut the flap off short, the knife is turned in such a manner that the edge looks forward. The knife is now turned up. Note the change in the position of the hands of the operator as compared with Fig. 60. The line of the incision in the cornea-sclera, as far as it lies behind the base of the conjunctival flap, is designated by dots.

formance of the operation. The incision having been completed, the forceps are released and *the rest of the operation finished without fixation.*

3. **Iridectomy.** (Figs. 65 to 68).—In this procedure there are used **iris-scissors** (De Wecker's **pince-ciseaux** Fig. 69) and the **iris-forceps** (Fig. 70.) The patient looks well downward, and the closed

forceps, held in the left hand between thumb and forefinger are introduced vertically from above, through the wound alongside of the iris, to the pupillary margin, with the concavity of the blade forward. The forceps are then opened slightly and a narrow fold of iris is seized, drawn forward and quickly cut off with the scissors held in the

Fig. 65.—Second step. Iridectomy.—The eye is fixed no longer. With the thumb of the right hand, the assistant holds the upper lid up from the side in such a manner that the operator is not hindered in inserting the closed iris-forceps directly from above through the wound to a point very near to the pupillary margin. The right hand meanwhile holds the iris-scissors already opened close by, ready to quickly cut off the iris as soon as it is drawn forward. For the sake of clearness the conjunctival flap is not represented on this and the following figures.

right hand (Figs. 65 to 68). The hand guiding the forceps must take a position of marked flexion, in order to introduce the instrument exactly from above. Should the conjunctival flap interfere with the introduction of the forceps, it may be turned down over the cornea by aid of the closed scissors, while the forceps press the scleral edge of the wound slightly back.

The arms of the pince-ciseaux are best directed upward during the excision (Fig. 68), as by this maneuver we obtain most readily a narrow coloboma having the form of a pointed arch. It is, however, no mistake to make the cut with the arms of the scissors held parallel to the limbus.

4. In **opening the anterior lens-capsule** (Figs. 73 to 75) we employ

Fig. 66.—The blades of the iris-forceps held close to the pupillary margin have just been opened. Figs. 59 to 61 show in natural size the maneuvers in seizing and extracting the iris.

capsule-forceps (Figs. 71 and 72). The manipulation of this instrument is, it is true, somewhat more difficult than that of **cystotome.** The operator holds the forceps in the right hand between the thumb and forefinger, and raises the upper lid of the patient with his left hand,

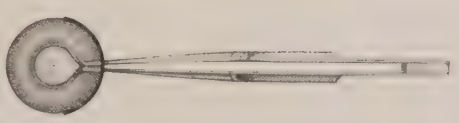

Fig. 67.—The blades have been closed and have seized a fold of the iris.

while the assistant draws the lower lid slightly away from the eye, the patient, meanwhile, looking well-downward. The closed instrument is introduced vertically from above (hence a position of the hand analogous to that in iridectomy), and pushed forward into the

Fig. 68.—The portion of the iris, which has been drawn forward, is cut off by the scissors brought from below.

anterior chamber until the dentated parts of the arms lie in the pupil, while their posterior portion is situated in the coloboma.

The forceps must be in such a position that both arms, when opened, glide along the surface of the anterior capsule (Fig. 74). A common mistake of the beginner is to hold the forceps obliquely so that only one arm lies against the capsule, while the other rests a greater or lesser distance away in the chamber. After the forceps have been

placed properly on the capsule, the instrument is opened as widely as the size of the pupil permits, although still greater opening may be obtained by permitting the arms to push the pupillary margin of the iris gently back. Next, under a slight degree of pressure exerted in the

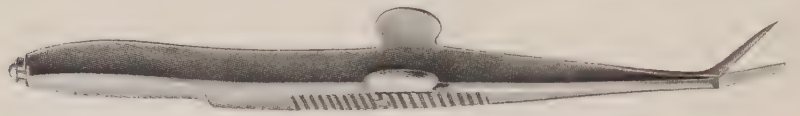

FIG. 69.—Iris-Scissors (Pince-Ciseaux, de Wecker).

direction of the lens, the forceps are again closed, and a fold of the capsule seized between the teeth, which are directed inward (Fig. 75), and torn loose from its surroundings by a slow pulling movement.

FIG. 70.—Iris-forceps.

The capsule-opening must be performed gently, and especially must the separated piece of capsule be drawn slowly from the eyeball in order that it be not detached from the forceps and left folded up in the wound.

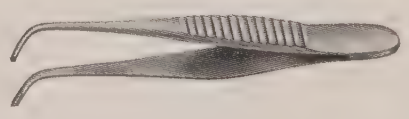

FIG. 71.—Capsule-forceps open (side view.)

After withdrawing the forceps it is desirable to ascertain that the piece of capsule is in their grasp and does not by any mischance remain behind in the wound. Ordinarily, there is obtained a somewhat round piece of the anterior capsule, which is usually about the

FIG. 72.—Capsule-forceps closed, showing the toothed portions only in contact.

size of the pupil but may sometimes be much larger. The degree of pressure needed to raise up a fold of capsule is very slight; if too much is exerted, there is obviously danger of luxating the lens. In order to avoid seizing the iris, the forceps must be constructed in such a

way that, when closed, the posterior portions of the arms remain apart from each other, and besides, in raising up the fold of the capsule, the forceps are so held, that only the toothed edges impinge, while the posterior parts of the arms are free in the chamber (Fig. 72). In extrac-

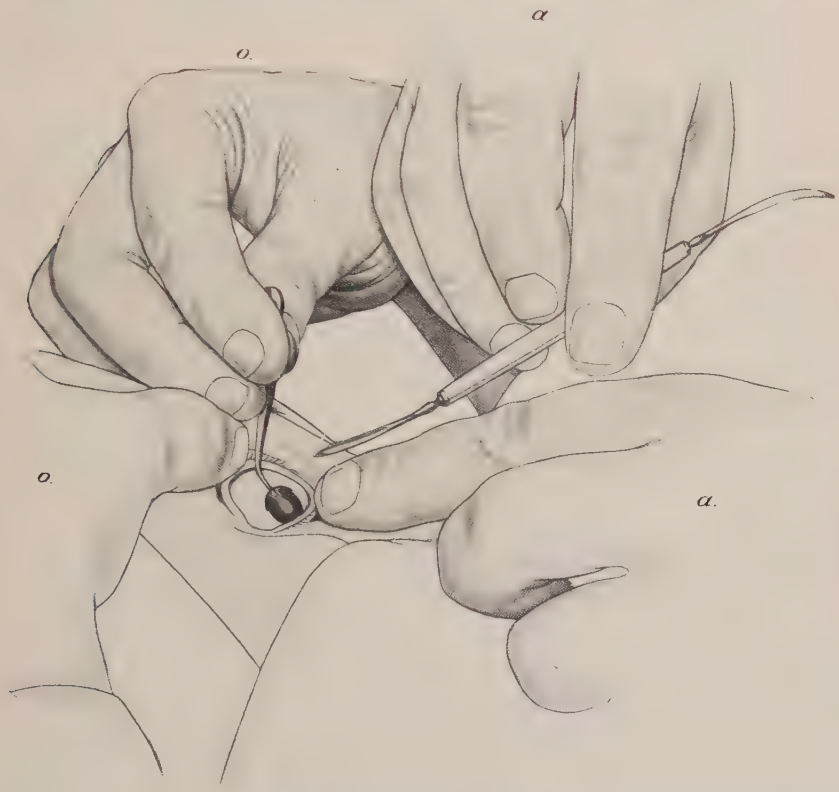

FIG. 73.—Third step. Opening of the capsule. The eye is not fixed. The operator himself is holding the upper lid elevated with his left hand, while with the right he is just beginning to introduce parallel to the plane of the capsule the closed capsule-forceps. The assistant holds the lower lid slighty away from the eye, not only to freely expose the cornea, but also to prevent any pressure on the eye by the lid should it be forcibly contracted by the patient. The other hand of the assistant holds the spoon directed toward the upper lid in such a manner that he can bring it at any time and at once beneath the lid, if the patient should begin to wince and there would be danger of his pressing the upper lid into the wound.

tion with iridectomy this factor plays no rôle, as the posterior portions of the arms lie within the confines of the coloboma. On the other hand, in extraction without iridectomy, it is important, by these precautionary measures, to prevent a pinching of the iris.

Of greater relative simplicity is the opening of the anterior capsule

by means of the **pointed tenaculum of the cystotome.** During the introduction into the anterior chamber the tenaculum should be made to slide down close to the posterior surface of the cornea and parallel to it, so as not to become entangled. When it reaches the pupillary area, it turns through an arc of 90 degrees until the point is directed backward. It is then brought into contact with the anterior lens-

FIG. 74.—Diagram showing both blades of the capsule-forceps widely opened gliding over the anterior capsule.

capsule, and several superficial cuts are made in various directions. During this procedure, no degree of force is either necessary or permissible. The instrument is withdrawn from the eye in the same manner as it was introduced, that is, parallel to the corneal surface.

The great advantage of the capsule-forceps, which outweighs the

FIG. 75.—The blades have been closed and have grasped between them a fold of the capsule which is now being pulled out.

disadvantage of its somewhat more difficult manipulation, lies in the fact that a large opening is made in the anterior capsule directly in the pupillary area. The result of this loss of tissue is that the capsule cannot produce optical disturbances later on. Again, the remnants of the cataract left behind in the capsule-sac are exposed to the action of the aqueous humor, with the result that even in the operation for unripe cataract or when a large number of cataract-remnants are present, they usually undergo spontaneous absorption immediately after the operation.

5. **Expression of the Cataract** (Figs. 76 and 77).—The patient looks downward; the eye is not fixed. The manipulations which the operator must perform in order to deliver the lens from the eye are comprised in two different acts. While the upper lid is raised by

the thumb of the left hand, the forefinger of the right hand begins to exert **pressure through the lower lid** in an anterior-posterior direction against the region of the lower corneal margin. The imme-

FIG. 76.—Expression of the lens. The manner in which the operator holds his hands should be observed. With the thumb of his left hand, he raises the upper lid and at the same time pulls it slightly away from the eyeball. The forefinger of the right hand exerts pressure on the lower half of the cornea through the lower lid; this causes gaping of the wound and the edge of the lens presents in the wound. The assistant holds the spoon, as already described, ready, on the one hand, to care for the upper lid and, on the other, to roll the lens completely out of the eye after it has protruded half way.

diate result is that the lens rotates upon its horizontal frontal axis in such a way that the upper edge of the lens-nucleus is turned anteriorly, and presents in the wound, a procedure which the operator has to

watch very closely. The wound begins to gape and in it the edge of the lens begins to appear. This pressure must be made with great caution, and only with gradually increasing force, in order to prevent a rupture of the hyaloid membrane.

From the moment the edge of the lens presents in the wound, the direction of the pressure is to be changed from below upward, as a further continuance of the backward pressure would only cause the vitreous to appear. The lens is now pushed up and out of the wound by a stroking movement exerted on the eye with the assistance of the lower lid. It is not permissible, however, to stroke upward above the middle of the cornea, as this would compress the

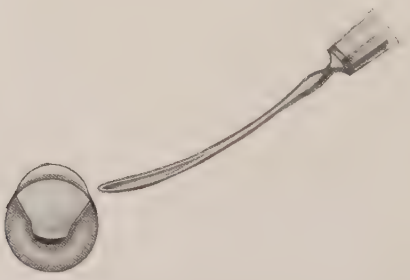

FIG. 77.—Diagram showing the spoon just about to be applied to the lateral margin of the half-delivered lens so as to roll it completely out.

wound and cause the lens to retreat into the eye. As soon as the upper half of the lens has passed the wound, the assistant applies the spatula to the margin of the nucleus and removes it from the eye (Fig. 77). At the same time the operator ceases pressure. The presentation of the lens-border in the wound can be facilitated by a slight depression of the scleral edge of the wound through the aid of **Daviel's spoon.** In the average case, however, this is not necessary, and we only use this depression when the delivery of the lens is accompanied by some difficulty.

After the exit of the lens, the upper lid is at once guided carefully down over the eye, so as to prevent the wound from gaping. Through similar stroking and kneading motions, any cortical remnants still remaining behind, are brought out through the wound. The more carefully this is done, the less likelihood there will be of secondary cataracts. Sometimes lens-tissue remnants are brought up from below behind the iris by this **massage,** and the pupil, which at the outset appeared black, turns gray again until the particles of tissue

have passed into the wound. Their removal is, at times, anything but easy. Occasionally they can be got out by inserting Daviel's spoon into the anterior chamber. But while doing this the operator must not go too far in his endeavor to get the pupil as clean as possible. As soon as it is seen that the wound shows an inclination to gape, and the vitreous is bulging forward and is in danger of prolapse, it is better to desist

FIG. 78.—Reposition of the inner margin of the coloboma. The eye is not fixed. The operator himself holds the upper lid in the same manner as above. His right hand introduces the spatula from without, obliquely into the inner angle of the wound, in order to smooth the iris down from this point. The lower lid is drawn slightly away by the assistant.

from attempts at removal of the remnants, and to end the operation. It may happen that although the pupil is thought to be free of cortical substance, on the day after the extraction it is found to be full of swollen masses of lens material. At the time of the operation this material was transparent, and, of course, could not be detected.

6. **Toilet of the Eye** (Fig. 78 to 81).—This represents the final stage of the operation, and the most important part in it is the **reposi-**

tion of the iris. After removal of the lens it is often hard to recognize whether the iris is really in a correct position.

We cannot expect to see in every case sharply projecting sphincter-angles. Occasionally the iris has been excised in such a manner that one of the angles produced is extraordinarily obtuse. Of only really great importance is the position of the sphincter, which can be recognized through its color being different from that of the rest of the iris.

FIG. 79.—Reposition of the outer margin of the coloboma.—The operator himself holds the upper and lower lids by means of the thumb and forefinger of the right hand, while the spatula is introduced with the left hand from the inner side obliquely into the outer angle of the wound and the iris smoothed back.

It is true, however, that through the presence of hemorrhages on the iris, a proper view can be hindered. The reposition is achieved by the spatula which is pushed carefully through the lips of the wound into its angle (Fig. 80). The spatula must be held parallel to the plane of the iris, as the turning of the end backward will result in injury of the hyaloid membrane and prolapse of the vitreous. When the anterior chamber is reached, gentle pressure is exerted on the iris, one edge of the spatula

being turned slightly posteriorly at the same time (Fig. 81). By moving the spatula toward the center of the pupil, the iris is stroked into its proper position. It is of no importance which hand is used in this manipulation. We employ alternately, as a rule, the right and left hand for the right and left angles of the wound, respectively. In many

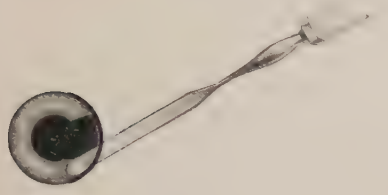

FIG. 80.

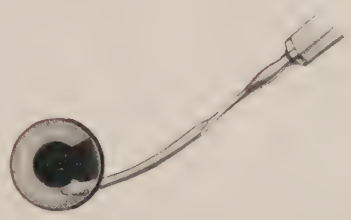

FIG. 81.

FIG. 80.—Diagram representing the eye and spatula during the reposition in natural size. For the purpose of reposition the spatula is introduced into the angle of the wound between cornea and iris.

FIG. 81.—In order to accomplish the backward stroking more easily, the spatula is rotated a few degrees (set on edge) and then by a suitable movement the angular extremity of the sphincter is smoothed down.

cases one can smooth the iris out directly from above downward, by holding the spatula in a vertical manner.

The proper position of the conjunctival flap is to be considered last. This should be carefully stroked into its intended position by aid of the spatula. Occasionally the conjunctival flap is included in the wound, which naturally causes a material disturbance in its closure.

After the conjunctival sac had been freed of blood and lens remnants, the eye is closed and a **binocular bandage** applied.

CHAPTER XII.

EXTRACTION OF SENILE CATARACT (Continued).

ACCIDENTS AND COMPLICATIONS.

The foregoing description concerns the operation for extraction of senile cataract when no undue incidents have occurred. Untoward accidents, however, may complicate each stage of the operation, and these complications are described and classified under the particular stage of the operation in which they occur.

1. **Fixation of the eyeball.**

The conjunctiva may be torn out. In elderly people the conjunctiva is often very friable, and in grasping it the forceps are likely to tear out. In case of this accident, if the operator is already in the midst of the incision and the patient does not of his own volition look downward, a muscle-insertion must be seized with the forceps, either that of the inferior rectus, or, preferably, of the superior rectus, the eye being pulled somewhat forward out of the orbit. It would be useless to seize the conjunctiva in another place, for it would tear out again. It is not permissible to bring the knife to a standstill while it is in the anterior chamber, as the aqueous humor escapes and the iris falls in the way of the knife. The only disadvantage of grasping a muscle-insertion lies in the fact that if the incision is not yet commenced, the knife in the act of making the puncture causes a marked rolling of the eye, which renders the beginning of the cut somewhat difficult.

2. **The incision.**

The experienced operator rarely fails to get the cut in the desired position, while with the beginner the opposite is often the case. The errors possible in regard to the incision concern: a. the position; b. the length; c. the manner in which it is executed.

a. The incision may either fall **too far forward** in the cornea, or **too far backward** from the limbus in the sclera. The latter especially occurs when the operator is a novice, and is usually due to the following circumstances. The puncture at the limbus is naturally quite easy. On the contrary, the counterpuncture is much more difficult on account of the already described relations of the peripheral part of the

anterior chamber. If the knife is pushed on directly into the angle of the chamber, the sclera is pierced in an oblique direction and the knife is seen to appear far behind the limbus beneath the conjunctiva. In order to bring the knife out directly at the limbus, the point should be steered toward a spot in the cornea about 1 mm. distance inward from the limbus. The operator, looking at the eye from in front, thinks that the point of exit will be much too far in the cornea, and is surprised to see, in spite of this, the point of the knife appearing in the limbus or close behind it. Hence, the novice may naturally fall easily into the opposite error, of making the counterincision much too far into the cornea.

Both of these abnormal incisions have great disadvantages. The peripheral incision in the sclera is usually accompanied by **severe hemorrhage,** which renders the operation exceedingly troublesome, the more so as the blood from the wound situated higher up, continues to flow into the chamber and hides the iris and lens from the operator's view. Besides, the incision is quite **painful** for the patient, as the cocain has not the same effect on the sclera as on the cornea.

Because of the position of the peripheral incision, the knife passes through nearly in the plane of the iris. This is the reason why the **iris falls into the way of the knife** and why a large piece is excised, the lens-capsule being in addition frequently injured at the same time. When we consider that the patient in consequence of the painfulness of the incision usually winces, we have an explanation why this single error in making the incision, which is so frequently seen in the extraction by the novice, gives rise to the common distressing experience of wound of the iris and lens-capsule—the lens protruding through the gaping wound, and behind it the vitreous pouring out.

Gaping of the wound is in general one of the great disadvantages of peripherally situated incisions, particularly as it predisposes to an extensive prolapse of the vitreous. It may almost be said that an incision situated too far forward in the cornea is better than one made too far in the sclera, but it also has objections, the chief of which is its relative **shortness.** The further into the cornea the incision, the more it becomes shortened from the arch to its chord. The delivery of the lens is consequently made more difficut. This will be discussed further, later on.

A high grade of **astigmatism** is another unpleasant sequel of corneal incisions and unfortunately it may remain permanent. The formation

of an **anterior synechia** is another no less disagreeable complication, as the periphery of the iris cannot be excised, and in consequence increase in tension may follow by the obturation of the angle of the chamber.

The greater liability of the corneal wound to **infection** is of less significance nowadays, since the operation is performed under antiseptic precautions.

b. **The length of the incision.**

On an average the incision should include about **a third of the corneal periphery.** No difficulties are presented in finding the right point of the insertion—1 mm. above the end of the horizontal meridian. Only through an abnormally oblique passage of the knife through the anterior chamber, an improperly situated counterpuncture can result, in consequence of which the cut will be too short. The relative shortness of a corneal incision has already been mentioned. The type of patient must, however, be always taken into consideration in determining the length of the incision. If a comparatively young individual (in the early forties), in all probability a shorter incision will suffice, as at this age the lens nucleus is still small. Greater length of the incision at the very outset is to be considered, if a **large brown cataract,** a **totally sclerosed lens,** is present. Should the patient have an **abnormally small cornea,** the incision must be begun further below, if necessary at the horizontal meridian, to insure a diameter of sufficient size.

c. **The manner of performing the incision** deserves a special discussion. The first rule to be observed is **under no circumstances to withdraw the knife** after it has once pierced the outer tunic of the eye and entered the anterior chamber. The beginner, becoming frightened at seeing the knife pierce a small bit of iris, draws the knife backward in order to free it. The immediate result is escape of the aqueous humor, and instead of a small piece, the whole width of the iris must now be cut through. It is never permissible to draw the knife backward, nor even bring it to a standstill. The counterpuncture once completed, no delay is allowable, and the incision is to be continued immediately.

If it should happen that the anterior chamber has been entered with the edge of the knife *directed downward*, the counterpuncture is first to be made, and then the knife rotated as quickly as possible 180° in its long axis, so that its edge becomes directed upward. The quick rotation

prevents the escape of the aqueous humor. Turning of the knife in the wound is without disturbing consequences, if its edge passes the arch in the direction toward the cornea.

In making the puncture, if the knife is held with its point directed too far forward, it may happen that, instead of entering the anterior chamber at once, the blade courses between the lamellæ of the cornea for some distance—the so-called **intralamellar incision.** This error results in a wound much too small. An intralamellar incision is, however, rare in the cataract-operation, as the anterior chamber is usually deep and the operator has no fear of piercing the limbus perpendicularly, as in the operation for glaucoma, where the danger of injuring the lens is always present. If the improper direction of the knife between the lamellæ of the cornea is noticed early enough, that is, before a puncture into the anterior chamber has resulted in escape of the aqueous, the knife can be withdrawn and the incision repeated at once in the correct place. If the aqueous humor has already escaped, the operator must continue with the incision, no matter how it terminates, and eventually widen it later with the scissors.

The surface of the knife blade must always be parallel to the surface of the iris. Only in this way is it possible to continue cutting in the same plane. Should the edge of the knife be turned slightly forward, the incision deviates anteriorly into the cornea; if directed a trifle backward, it is made more and more obliquely into the sclera.

No direct pressure should be made with the knife; on the contrary, the blade is to be drawn through in an upward direction with long sawing movements. Pressure of the knife against the sclera stops its forward progress. Thus a novice may believe that he has a dull knife, while he himself is responsible for the poor incision.

The knife should be carried through the chamber in a horizontal direction. While it is lightly held between the thumb on one side, and fore- and middle fingers on the other, the handle of the knife rests upon the first joint of the forefinger. The little finger is supported in the region of patient's temple to prevent making a false cut, should he move unexpectedly.

After the sclera has been cut through, and the knife is beneath the conjunctiva, it is turned so as to cause the edge to look anteriorly. It is, however, **an error, to turn the knife while it is still embedded in the sclera,** as not merely irregularity in the wound will occur, but the incision will lie in a false position, too far into the cornea.

Finally, there is to be considered **which hand should make the incision?** To operators who are not naturally lefthanded, the cut made with the **left hand** does not present any unusual difficulties.

The surgeon who only employs the right hand must operate on the right eye from behind, and on the left eye from in front. There are operators who always operate from behind, and who, for that reason, must use the right and left hand alternately. The great objection to this position is that the surgeon must bend over the patient, a circumstance which certainly is not favorable for proper asepsis of the wound.

3. **Performance of the Iridectomy.**

The first complication to present itself during this step of the operation may be **hemorrhage.** If the incision bleeds considerably, the blood in the anterior chamber obscures the view, so that one has to seize the iris without seeing it. The actual cutting of the iris is usually not especially painful, as the cocain has a sufficient anesthetic effect.

The iridectomy is beset with difficulties if an **intractable patient does not look down,** or looks up or aimlessly around, and it may be impossible to seize the iris with the forceps. One may then draw it forward with a **blunt hook,** bent in a proper manner, and do the excision. We fix the eye with the forceps only with great unwillingness and only in case of absolute necessity while doing an iridectomy, as the fixation invariably causes the wound to gape.

An unpleasant accident which may happen in iridectomy is the production of an **iridodialysis.** If, after the iris has been seized with the forceps, the patient suddenly moves his eye or head, unless the operator is quick enough to release the iris, there may ensue a separation of the iris at its ciliary margin to a greater or lesser extent. As a rule a considerable hemorrhage occurs directly after, which greatly adds to the difficulties of further operating.

Should the **iris** during the incision **fall into the way of the knife,** a broad piece is usually cut out, which prolapses into the wound. If the prolapse shows in the incision at once, it requires only removal with the forceps. In other cases it must be removed from the anterior chamber. Only when it is still connected in one place with the rest of the iris, it has to be excised at that point.

If only the periphery of the iris falls into the way of the knife, a bridge-shaped coloboma is formed, in which a more or less wide portion of the pupillary margin persists. It is not necessary to draw it up and cut it off. Sometimes a narrow sphincter bridge cannot be

caught with the forceps, so that one has to resort to the blunt hook to pull it out. If the bridge is permitted to remain, it may either persist unharmed during the delivery of the lens, the nucleus passing through the coloboma, or it may tear away.

4. **Opening the capsule.**

In spite of the somewhat more difficult manipulation of the **capsule-forceps,** we usually prefer them to the cystotome, and only in certain selected cases use the sharp tenaculum. As that portion of the anterior capsule which corresponds to the pupil, presents an obstacle to vision, it is naturally better to remove it. The extensive absorption of the remnants of the lens in the presence of a large opening in the capsule has already been alluded to. However, there are circumstances in which the use of the forceps is objectionable. If the anterior chamber is filled with blood, and the boundaries of the pupil cannot be seen, the use of the capsule-forceps is likely to be dangerous, and by mischance a fold of the iris might easily be grasped by mistake and pulled out. In restless patients it is preferable to resort to the **cystotome tenaculum.** If the pupil is narrow, it may also be desirable to open the capsule with the tenaculum in an extraction without iridectomy, to avoid a possible seizure of the iris by the forceps.

The employment of the capsule-forceps will be influenced to a considerable extent by the condition of the capsule when dealing with a **greatly distended cataract,** and a hypermature, complicated cataract with **thickened capsule.** If the lens is so swollen that the capsule is tense, a fold of it cannot be lifted up with the forceps, except by exerting more force than is permissible. If the operator feels that he cannot grasp a fold of capsule between the teeth of the forceps by gentle pressure, he should effect the opening by the aid of the tenaculum as too much force will cause a prolapse of the vitreous.

Should the capsule be thickened, great care is demanded in the use of the forceps. It is, of course, an advantage to remove the thickened anterior capsule from the pupillary area, especially if it occupies the whole extent of the latter, as the dense membrane seriously impairs vision. In using the forceps it may happen that the thickened capsule offers more resistance than does a defective zonula; the fibers of the latter tear through and the whole lens in its envelope is withdrawn from the eye. In any event the operator must be prepared to assist in the exit of the lens by a downward pressure on the scleral wound-margin at the moment he sees the whole lens yielding. This is

done in order to remove the obstacle presented by the sclera, so that the capsule may not finally rupture and leave the half-luxated lens behind in the eye. If the patient is quiet and the vitreous of normal consistency, a prolapse of the latter does not of necessity accompany the extraction of the intact capsule. Sometimes such prolapse cannot be avoided. Should extraction with the capsule succeed, the terminal result is excellent, as the pupil is free of all remnants of tissue.

It is perhaps superfluous to state that the **pressure** to be exerted on the lens with forceps in opening the anterior capsule must be *gentle* in all instances. A luxation of the lens backward into the vitreous could possibly follow excessive pressure with the instrument.

5. **Expression of the cataract.**

The manner in which pressure is to be made on the eyeball to effect exit of the lens has already been described. If the operator does not exert it against the lower part of the lens, but instead presses too high up, perchance against the middle of the cornea, he will, of course, wait in vain for the appearance of the lens in the wound. However, in spite of pressure made in the proper manner and with a proper degree of force, the lens-nucleus may fail to appear in the wound and make its exit. This is a most critical moment for the operator, and here he must think right and act quickly, well mindful of his purpose.

The causes of such a contingency are as follows:

a. **The wound may be too small.** If the operator has begun the incision too high up, or, after an accurate puncture, has wrongly made the counterpuncture too far above, a relatively short incision is the consequence.

If it is seen that the lens-nucleus is pressing against the wound but can not make its way through, the incision must be *prolonged* either at one or both ends, with a small pair of curved blunt scissors, one blade of which is carefully pushed into the angle of the chamber between the cornea and iris, while the other blade remains on the outside of the eyeball. If shortness of the incision is the real cause that prevents the proper delivery of the lens, the latter easily slips out of the eyeball after the cut has been enlarged.

It may be, however, that though the incision is sufficiently long, the lens-nucleus may be exceptionally large. On this account, in cases of **black cataract,** the incision should be made larger than usually at the beginning of the operation. A cut which is too short, because made *too far into the cornea,* presents still another factor which may

hinder the exit of the lens. The further the incision in the cornea is removed from the limbus, the more must the edge of the lens rotate forward to present in the wound. That is, the greater the force which the operator must exert on the eye, the more danger there is of prolapse of the vitreous. Therefore, the only thing to do to facilitate the extrusion of the lens is to prolong the incision by making lateral cuts along the limbus, and the same procedure is indicated if it is too short, on account of being made for some distance *between the corneal lamellæ.*

b. **The sphincter may offer too great resistance.** This will be discussed when describing extraction without iridectomy.

c. **The anterior lens-capsule may not have been opened.** The operator who can see the fold which his forceps have raised in opening the capsule, or has at least convinced himself of the presence of a piece of the membrane between the branches of the forceps after they are withdrawn, will always feel safe against this error. If he is not certain of having sufficiently opened the capsule, he should introduce the forceps a second time or have recourse to the cystotome.

d. A fourth possible causative factor is **dislocation of the lens,** usually a slight **subluxation upward.** This may be due to traction of the forceps on the capsule, to pulling too strongly on the tunics of the eyeball during the incision, or to the initial pressure having been exerted in a direction, which pushed the lens slightly upward instead of rotating it about its horizontal axis. Consideration of the associate physical conditions renders clear the impossibility of delivering the lens. The pressure made by the finger naturally falls only on the vitreous, and has no longer any influence on the position of the lens. The latter does not rotate its margin into the wound, and the operator who thinks to accomplish this purpose by increasing the pressure simply forces the vitreous into the opening, at the same time completely luxating the lens backward. The removal of the lens can then only be accomplished by *returning it to its original position,* which may be obtained by introducing a spatula into the anterior chamber and bringing the instrument into contact with the anterior surface of the lens, pushing it downward into its normal position. After this maneuver the expression of the lens is at once obtained by pressure exerted.

If the lens becomes luxated in any direction other than upward, for example, internally or externally, it must be treated as described elsewhere.

When the **lens-nucleus** has become considerably **diminished in**

size, its exit may also be more difficult, as is frequently seen in complicated cataract and invariably in over-ripe cataract (Morgagnian cataract). One understands that the employment of pressure, in the manner just described, is absolutely useless, if the lens is not normal in position and size. If the cortical substance has liquefied and pours out after the anterior lens-capsule has been opened, the small nucleus either sinks down to the bottom of the capsule-sac or is carried slightly upward behind the iris by the escaping cortical matter. In neither of these two instances is it possible through the regular expression to influence the position of the lens-nucleus. Pressure is absolutely contraindicated. If the lens lies far down, it may be gradually worked upward **by gentle stroking movements,** and finally brought out of the wound with **Daviel's spoon.** If, however, it has been pushed up behind the iris, it must be first stroked down by means of the spoon into the pupil and from there guided upward out of the wound.

6. **Prolapse of the vitreous** is the most unpleasant of accidents, and, although it does not usually occur until during the act of expressing the cataract, it may happen in any of the stages of the operation. It is of less significance when it ensues **after the removal of the lens,** and that time it is best to do nothing further than make sure that the corneal flap remains in its proper position, and is not bent forward through the pressure which the vitreous exerts from behind. To undertake a reposition of the iris is not advisable, as by doing so there would only be caused further protrusion of the vitreous. The best procedure, therefore, is to close the patient's eye immediately the vitreous appears, the upper lid being carefully guided over the flap with the assistance of the spoon held beneath the lid. As the protrusion of the vitreous causes pain, the patient usually winces, which may cause still more vitreous to be pressed out of the eye. Moreover, it is easily possible for the upper lid to fall into the open wound and to turn the flap forward. This accident will be discussed more fully when speaking of the duties of the assistant during the cataract-operation (p. 237).

After the patient has closed the eye, the upper lid is slightly raised with great care (best by means of the eyelashes) and at the same time the lower lid is drawn away from the eye. The position of the flap behind the upper lid may then be inspected, and, if necessary, is smoothed out by a spatula. After this, the patient should not be allowed to open his eye and for this reason it is of advantage to keep the other eye also closed by a bandage.

When the vitreous appears prior to the removal of the lens, the accident naturally becomes much more troublesome. If the iris has not as yet been excised, an iridectomy can only be performed if the iris has been so floated into the wound by the vitreous that it can be seized readily by the forceps and cut out. If, however, the iris has not fallen forward, any attempt to seize it with the forceps must be hopeless, as the instrument picks up only the vitreous, never the iris, which had been pushed backward toward the ciliary body, so that a large coloboma upward is to be seen.

Expression of the cataract after appearance of the vitreous is impossible, since every time that pressure is made a further prolapse occurs. Instead, **extraction of the lens in its capsule** must be resorted to, and for this purpose, either a **loop** (Weber's) or a **double tenaculum** (Reisinger's) is employed, the manipulation of the former being easier for the beginner.

The loop, (Fig. 82) directed *obliquely backward* (Fig. 83), is introduced through the wound, until it reaches a position in the middle of the vitreous and about opposite the posterior pole of the lens. It is then turned forward in such a way (Figs. 84 to 87) that the

FIG. 82.—Weber's loop.

lens is pressed against the posterior aspect of the cornea and glides out between the cornea and the instrument; in other words, it is lifted out of the eye by the loop.

Reisinger's double tenaculum (Fig. 87) is inserted closed into the vitreous area in a manner similar to that used in introducing the loop. in order that the points of the tenaculum may not become entangled in the edges of the wound, the instrument is held with the plane of the bent portion parallel to the wound, therefore, in a frontal direction. Not until the instrument is found to be behind the middle of the lens, is it rotated about 90° on its long axis, so that the points are now directed forward. The two arms are then permitted to separate and sink into the posterior surface of the lens, which is now pressed against the posterior aspect of the cornea and in this manner withdrawn from the eye. This instrument, therefore, can only be used when a firm lens-

nucleus is present. If the nucleus is soft, the loop is recommended, as the tenaculum would cut through the soft mass without bringing it out.

Both the instruments must be carried backward into the vitreous in an oblique manner, for the reason that if held vertically, they would

FIG. 83.—Introduction of Weber's loop in case of escape of vitreous prior to the delivery of the lens. The loop is directed backward through the gaping wound behind the lens into the vitreous. The assistant holds the upper lid well-fixed with the thumb of the right hand and has the spoon in the left hand ready, after the extraction has been completed, to guide the upper lid down over the gaping wound. The operator himself fixes the lower lid.

push against the margin of the lens and produce a luxation into the vitreous. During the entire manipulation, the lids must be drawn away from the eye, so that they can exert no pressure on the globe.

The upper lid is best raised by means of a **Desmarres spoon.** In every cataract-operation the loops and tenaculum should be kept near at hand and sterilized, as prolapse of the vitreous occasionally takes

FIG 84.—Second step of this procedure. The loop has been placed upright in such a fashion as to press the lens against the posterior aspect of the cornea and can now be drawn along the latter and out of the eye.

place in operations in which a completely normal course had been expected.

Generally speaking, the greater the dexterity of the operator, the rarer will be prolapse of the vitreous in uncomplicated cataract. Severe straining, holding the breath, etc., on the part of the patient may be responsible for the accident, while the surgeon may induce the prolapse

by undue pressure on the eye with the forceps during the incision, in delivery of the lens, or in scraping out the lens-remnants. Quite unavoidable often is the prolapse in the presence of complicated cataracts, when the zonula is destroyed, or the vitreous has lost its normal consistency.

Prolapse of the vitreous is the most serious complication in the operation for cataract-extraction, and it is absolutely necessary to recognize at the right time whether a prolapse is imminent, and if so, to prevent it if possible.

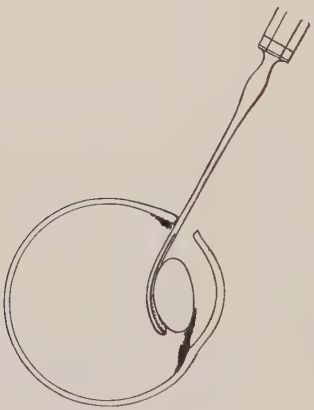

Fig. 85.

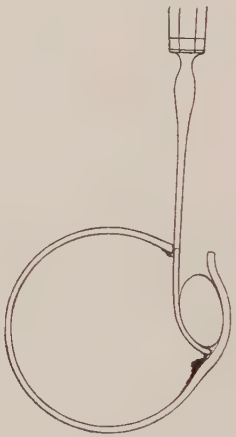

Fig. 86.

Fig. 85.—Diagrammatic representation of the introduction of the loop. The loop is directed backward in an oblique manner.

Fig. 86.—The loop is raised up and the lens pressed against the posterior wall of the cornea.

Several phenomena are associated with this complication:

1. Very characteristic is the **forward bulging** through the pupil and coloboma of the vitreous with the hyaloid membrane still unruptured. If after the expression of the lens-nucleus, the pupil and coloboma are filled with greyish lens-remnants which suddenly separate at one point, and the pupil in this locality becomes a deep black, we have the first sign that the vitreous, still contained within its uninjured membrane, has pushed forward and penetrated the tissues in front. Only the inexperienced operator will continue to exert pressure to remove the remaining lens-particles, for the rupture of the hyaloid membrane

would occur the next moment. It is better to be satisfied with carefully stroking back the iris, and even this is only possible if the patient remains correspondingly quiet, but it often becomes displaced again through the vitreous pushing forward.

2. The same bulging forward of the vitreous in the unruptured hyaloid membrane may also occur with a simultaneous marked deepening of the anterior chamber. A **hernia of the vitreous** presses at the same time through the pupil into the anterior chamber, filling it out and pushing back the iris.

3. Another characteristic sign is the **deepening of the anterior chamber** in consequence of the accumulating vitreous, which is already poured in through a rupture in the hyaloid membrane. This is naturally followed at once by an outflow of the vitreous through the wound. The first indication of the vitreous flowing into the anterior chamber is occasionally manifested by changes, which the blood undergoes

FIG. 87.—Reisinger's double tenaculum.

through coming into contact with the vitreous. It coagulates into thread-like clots becoming lighter in color.

Deepening of the anterior chamber may also be produced by the **entrance of air,** but as the **air-bubble** is always clearly seen, it cannot be confounded with the appearance just described as due to the vitreous. The air in itself is not harmful, but it may so disturb the apparent relations of the anterior chamber, especially the position of the margins of the iris, that an attempt should be made to remove it from the eye by massage. As the air is easily sucked in again, this measure is usually valueless.

4. If the lens is still in the eye, the tendency to vitreous-prolapse is indicated by a **turning up of the edges of the wound,** and in consequence **the wound gapes.** While vitreous-prolapse may sometimes be caused by the patient holding his breath or straining down, in other cases no cause can be found, the prolapse occurring unexpectedly. Especially during peripheral incisions the hyaloid membrane may rupture in the region of the wound, and the vitreous extrude through the widely gaping wound, without any previous sign whatever having been noticed in the anterior chamber.

If the vitreous is perfectly fluid, it will ooze steadily from the eye

immediately after the incision, without any gaping of the wound. Great loss of fluid is only recognized by **collapse of the eyeball.** As this precludes regular extraction of the lens, the loop or tenaculum must be resorted to. On the whole, the loss of perfectly fluid vitreous is in general much better tolerated than the loss of the normal vitreous. In a few hours it is replaced by new fluid, which returns the eye to its normal state of tension. As the wound does not gape, it heals smoothly; whereas, in the loss of normal vitreous, the cicatrix remains ectatic for a long time.

In the rare instances in which the protruding vitreous constantly turns the corneal flap forward, and it cannot be retained in its proper position by stroking it back with the spatula, nothing remains to be done except to fasten it with two or more silk sutures.

When the dressings are changed on the day after the operation, it may be found that the **corneal flap is turned downward.** This is caused by the patient with a gaping wound opening the eye beneath the bandage, so that the upper lid in closing enters the wound. After instilling cocain-solution the flap must be carefully stroked upward and brought into its proper position. If no infection ensues, which, however, is a likely result, the eye need not be considered as lost. For a long time a straight white line is retained as a sign of the corneal injury.

The sequelæ of prolapse of the vitreous may in all cases be serious. A replacement of the iris is impossible, and, therefore, an attachment of its margins to the wound is a usual occurrence, in consequence of which cystic scars, glaucoma, and signs of irido-cyclitic irritation often appear. **Hemorrhage** into the open vitreous chamber may lead to marked opacities which later are seen as free floating membranes or hang into the vitreous chamber from the point of attachment. **Detachment of the retina** occurs only after great loss of vitreous except in an eye especially predisposed (myopia, etc.).

Several other accidents during the cataract operation must be mentioned.

The lens may be displaced back into the vitreous chamber, either spontaneously or through the unskillful manipulation of the operator. In such case any attempt to recover it is useless and results only in further injury to the eye. The operation has to be stopped and the eye bandaged. Iridocyclitis often follows this accident.

The so-called **collapse of the cornea,** which is occasionally met with during the operation for cataract, is of absolutely no importance.

Immediately after completing the incision, or after expression of the lens, the cornea sinks down so that a depression appears. This happens in softened eyes, and when the cornea is flabby, especially in old people, whose cornea is often extremely atrophic.

Expulsive hemorrhage is fortunately an infrequent complication. It may occur during the course of the operation, but usually appears suddenly several hours afterward; it is seen not only after extraction complicated by the loss of the vitreous, but also following operations with a perfectly normal course. The hemorrhage is retrochorioideal and is so extensive that the vitreous, chorioid and the retina are driven outward through the wound. Immediate enucleation spares the patient a long period of suffering. Unfortunately, we have no means to prevent this accident; indeed, we do not even know of a single symptom which will afford warning of the danger before the operation. As associated factors the following must be taken into consideration: the sudden lowering of the intraocular pressure caused by the operation; the rigidity of the external tunic of the eye; arteriosclerosis and the concomitant tendency of the blood-vessels to rupture; and increase in blood-pressure occurring during the operation on account of the increased activity of the heart due to the excitement of the patient. To at least exclude the last factor, Fuchs gives those patients who have lost one eye through an expulsive hemorrhage, a large dose of bromids before the operation (two grams). The danger that hemorrhage may follow extraction of a cataract from the other eye is not sufficiently great to warrant the operator in performing a depression of the cataract into the vitreous humor after the old method instead of the usual extraction. Here it may be mentioned that we do not perform **preliminary iridectomy,** either in unripe or complicated cataract, it having no special advantage; on the contrary, it adds to the danger of a second operation.

EXTRACTION WITHOUT IRIDECTOMY.

Apart from the cosmetic standpoint there is no sound argument that can be advanced in favor of the operation without iridectomy. On the contrary, this method possesses several **disadvantages,** which must not be underestimated. Prominent among these are the necessity of a second operation in case of subsequent prolapse of the iris, and the increase in pressure caused by the occasional distortion and fixation of the iris to the scar.

Indications.—This operation may be performed if it is certain

that the patient will lie quietly in bed afterward; hence, it should never be undertaken in very old people or if the patient has a cough. If there is good vision in the other eye, extraction without iridectomy may sometimes be permissible. If, however, the other eye is incapacitated or its vision diminished in consequence of some disease apart from incipient cataract, the extraction must always be performed with iridectomy so as to avoid any complications. To be successful, extraction without iridectomy further depends upon certain conditions of the eye. With a narrow pupil and a large lens-nucleus, it is readily understood that the operation must be done with an iridectomy; the same is true in all cases of complicated cataract. Therefore, it is only when the iris tends to retain its position in the eye and shows no inclination to fall forward, and the course of the operation promises to pass off uncomplicated, should the careful operator conclude to perform extraction without iridectomy. Hence, it often happens that it is not decided to do the iridectomy until after delivering the lens-nucleus through the round pupil. If it is seen that, in spite of persistent attempts to replace the iris, the pupil draws upward after each reposition, or even if it is suspected that the iris will prolapse later, iridectomy is indicated. Because of these precautions the reported percentage of prolapse of the iris on the day following the operation is comparatively small. It occurred in 8 per cent. of my patients, of which about one-third were operated without iridectomy, and it must be understood that among this 8 per cent. there are included all those cases in which the pupil was not absolutely round, but only slightly oval-shaped, without a real prolapse in the wound.

The opening of the capsule may be difficult in patients with **narrow pupils,** and in such cases it is advisable to use the small tenaculum instead of the forceps. A narrow pupil is often a marked impediment in the delivery of the lens, especially if the nucleus is large. The operator must decide whether or not the lens can be delivered through the pupil without the use of too strong pressure, and if not, perform an iridectomy rather than risk a prolapse of the vitreous by exerting excessive force.

The **assistant** can facilitate the removal of the lens when the iris is stretched over the protruding nucleus by attempting to push it over its edge at its pupillary margin with the spatula. The resistance of the sphincter, which is particularly rigid in the iris of old persons, is sometimes considerable. The sphincter is occasionally torn when the

lens pushes through, and it is then better to perform an iridectomy, since the relaxed and lacerated pupil fails to retain its normal position and becomes irregular through retraction of the margin of the tear. If a prolapse of the vitreous occurs during the operation, an iridectomy is then usually impossible, and the lens should be delivered with the loop or the double tenaculum, in the manner already described. The iris in the region of the incision is turned backward and it is only when the vitreous floats it into the wound, that the surgeon is in a position to excise a portion which should be as large as possible.

The removal of the cortical substance is more difficult in the simple than in the combined extraction. If during the expression of the nucleus, the pupil has been pulled upward and the iris presents in the wound, it is advisable to massage the soft remaining particles of the cortex out of the eye, as in this way only can success attend subsequent efforts to replace the iris. Once the pupil has regained its round contour, massage carries the lens-particles upward behind the iris, without bringing them out of the eye. Individual flakes contained within the pupillary space can be removed with the Daviel spoon.

The incision for simple extraction does not differ from that of the ordinary combined operation, but, here in particular, it should be the endeavor to make it exactly at the limbus.

After the operation it is customary to instill **eserin** into the eye, without, however, considering it of any great value. If, on the day following the operation, the pupil is not perfectly round, the wound is re-opened after thorough cocainization, and the iris resected; this is done even if the iris does not lie directly in the wound. In case of true iris-prolapse, iridectomy is a foregone conclusion. If the anterior chamber is re-established on the second day and the pupil round, the further use of eserin is quite unnecessary. If the eye is irritated, atropin may be employed as early as the second day.

Excision of the prolapsed iris is usually difficult, as the irritated eye cannot be made sufficiently insensitive by the cocain. The consequent wincing of the patient renders very likely prolapse of the vitreous. If the wound has re-opened with a conical probe, the operator should drop cocain directly on the exposed iris. After excising a piece of the iris, it is often an easy matter to stroke lens remnants out of the eye, which on the previous day could not be removed. Replacement of such prolapsed iris, without excising a portion, should not be considered, as in all probability the prolapse would recur.

CHAPTER XIII.

DISCISSION, OPTICAL IRIDECTOMY.

DISCISSION.

Under this heading are included 1, the **incision of the anterior lens-capsule** (the lens being either cloudy or transparent), and 2, the cutting of the **secondary cataracts.** For the performance of this

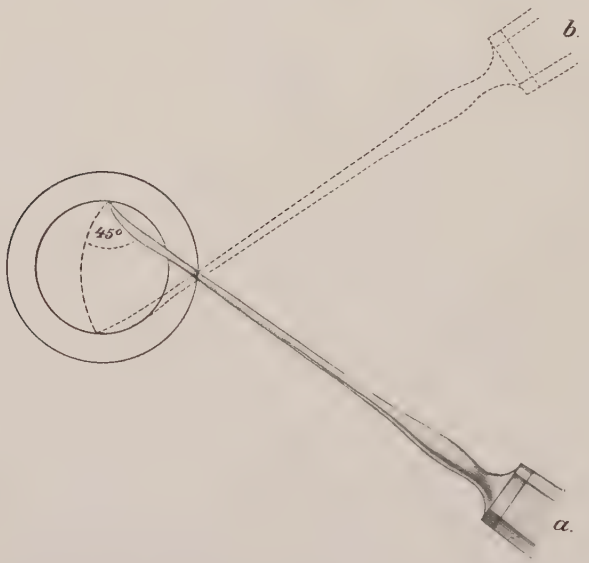

FIG. 88.—Discission through the cornea. Diagram showing how the vertical incision is made in discission through the capsule of the lens. The handle of the needle is lowered, thus bringing its point into such a position (a) that it lies near the upper margin of the pupil. Next, while the needle inclines to the plane of the lens-capsule at an angle of about 45 degrees, the handle is elevated from (a) to (b), thus making a vertical incision through the capsule.

operation **discission-needles** are employed, which are small knives with convex and concave cutting edges. The incision may be made either through the cornea or the sclera, and each operative procedure will be considered separately.

Discission through the Cornea (Figs. 88 and 89).—After the pupil has been dilated with atropin, the eyeball is fixed and the

cornea pierced on the outer side near the limbus. The operation on the right eye is best performed with the left hand, and on the left eye with the right hand, the operator in each instance sitting to the right of the patient. The dilatation of the pupil is intended not only to expose the anterior lens-capsule as much as possible, but particularly to protect the iris from injury.

The needle is held between the thumb and the first and second

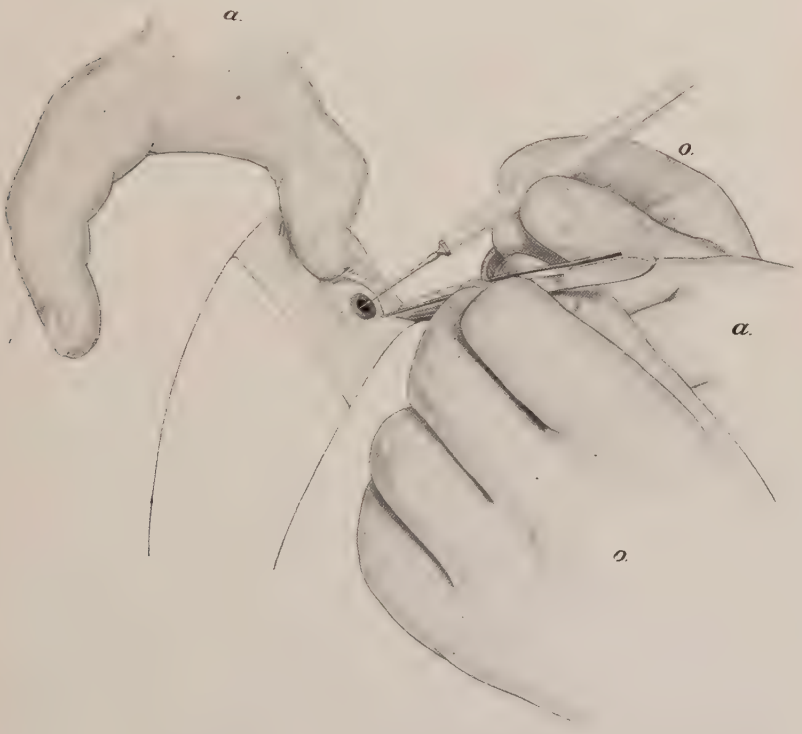

FIG. 89.—The eye is fixed below at the limbus by means of forceps. With the discission needle held in the right hand, when the left eye is operated on, the cornea is perforated at the limbus, and a horizontal incision is then performed through the anterior lens-capsule.

fingers, while its handle rests upon the base phalanx of the fore-finger. After perforating the cornea in about the horizontal meridian, the knife-point is pushed forward and upward, until it reaches the **upper** margin of the pupil. Using the corneal perforation as the rotating point, the handle of the instrument is moved from below upward, describing an arc of about 90 degrees, and held so, that its

long axis is inclined to the plane of the lens-capsule at about an angle of 45 degrees. In this way the point of the knife-needle makes an **incision into the capsule from above downward,** cutting through the lens-substance obliquely (Fig. 88). After completing the vertical capsular opening, the point of the instrument is brought back in the anterior chamber by depressing the handle, and approached to the **inner** margin of the pupil. Starting from an almost horizontal position of the needle, the handle of the instrument is elevated now through an arc of about 45 degrees, the corneal perforation being utilized again as a fulcrum. Through this maneuver the point of the needle describes a small arc and makes a **horizontal incision** in the anterior capsule of the lens (Fig. 89). In order that the point does not sink too deeply and injure the posterior capsule, the needle is withdrawn slightly while making the cut and finally quickly pulled out of the eye.

The most important precaution in the operation is to **avoid injuring the posterior capsule of the lens.** This accident may result from introducing the needle too deeply, and directing it too perpendicularly. On that account the needle should be made to glide obliquely through the substance of the lens during the vertical incision, and be drawn out of the eye during the horizontal incision. If the instrument is inserted too perpendicularly, a perforation of the posterior lens-capsule readily occurs.

The opening in the anterior chamber may be made either in the outer part of the cornea or in the limbus itself or even beyond it in the sclera. In entering through the sclera the needle is pushed forward slightly under the bulbar conjunctiva before the perforation is completed. This produces immediate closure of the perforation-wound, as the opening in the conjunctiva and that in the eyeball occupy different positions. However, entering the knife through the cornea is preferable in those cases in which, because of a shallow anterior chamber or a pupil which has remained small in spite of atropin, an injury to the iris is to be feared if a peripheral incision is made.

As for opening in the capsule we prefer a **crucial incision,** because a permanent opening is thereby assured. The four flaps retract, so that a healing of the wound in the capsule is absolutely prevented. If only a single incision is made, closure of the wound not infrequently occurs. On the other hand more than two incisions are superfluous.

The aqueous humor should not be allowed to escape during

the operation. On this account, the needle must be quickly withdrawn from the eye. Through the escape of the aqueous humor, adhesion of the iris to the place of perforation may develop, thus leading to the formation of an anterior synechia.

Discission of a transparent lens is only undertaken in high-grade myopia, for the purpose of completely removing the lens. The immediate consequence of discission is, of course, a traumatic cataract. The rapidity with which this forms depends chiefly upon the size of the capsular wound. If only a single cut has been made, the opacity not infrequently remains limited to the tissue immediately surrounding it as the capsular wound may close in the meantime. Therefore, if after a few days, the cataract should make no progress, it is best to **repeat the discission,** and to incise the capsule of the lens more freely. If the anterior lens-capsule is opened sufficiently, there is not only a total opacity of the lens quickly produced, but also a swelling of the lenticular substance which soon fills the anterior chamber.

The swollen lens-substance is rather slow in being absorbed and many weeks may be required, during which the eye is in a state of constant irritation. Hence, we prefer after about fourteen days, by which time the entire lens has become opaque and soft, to remove the masses from the eye by an incision made with the lancet at the lower corneal margin (analogous to linear extraction). Provided the posterior lens-capsule has not been injured by the discission, this trifling operation is performed without accident, especially as an incision 5 mm. long usually suffices. If, however, the posterior lens-capsule has been injured in performing the discission, **prolapse of the vitreous body** into the wound is the immediate consequence. This, of course, makes impossible the massaging of the soft lenticular masses from the eye, as more vitreous would be squeezed out. The iris is likewise displaced from its proper position by the vitreous and remains permanently distorted. For the foregoing reasons the operator should be particular not to injure the posterior lens-capsule.

During the period of swelling of the lens, the pupil must be kept widely dilated by atropin. The development of the cataract is sufficient in itself to set up a state of intense irritation and ciliary hyperemia; and atropin is necessary, not only to hinder the formation of posterior synechia, but to freely and constantly expose the capsular wound and prevent incarceration of the swelling lens-substance in the narrowing pupil, which would soon terminate in **increase of pressure.** The

latter, moreover, not infrequently follows the swelling of the lens after discission, and especially when the incisions are free so that the swelling takes place rapidly. If the tension increases and the pupil is not dilated sufficiently, it should be our first task to open the pupil as much as possible by thorough cocainization followed by the application of dry atropin, and at the same time apply iced compresses to the closed lids which exercise a beneficial influence. If the pupil is sufficiently dilated, we must not instill miotics with the hope of decreasing pressure. If the glaucoma does not disappear within 24 hours and at the same time is considerable, a puncture of the anterior chamber will remove it permanently, by which we try to get out as much of the swollen lens as possible, as previously described.

The indications for the operation in high-grade myopia are as follows:

1. The degree of myopia must be more than 16 diopters; if patients with less myopia are operated on, they will require after operation convex glasses for distance vision and still stronger lenses for near vision. The difference in the refraction produced by the removal of the lens in myopia amounts to nearly 20 diopters on an average, as against 10 diopters in normal eyes.

2. The visual acuity of the eye to be operated upon must not have suffered too severely through intraocular changes and must at least be one-sixth to one-quarter of the normal and not seriously disturbed by a central scotoma.

3. The patient's other eye must still be useful, that is, it must not have suffered detachment of the retina, severe chorioiditic processes, or other diseases.

4. The operation is limited to patients under forty years of age.

Narrowing the foregoing indications down to these limits, the results obtained by the operation are on an average good. It is of the greatest importance to **guard against injuring the vitreous** during the operative procedures. It must be remembered that in high myopia the vitreous shows a marked tendency to become diseased. But it becomes frequently impossible to leave this humor permanently undisturbed. While it is the duty of the operator not to injure the vitreous in performing discission of the transparent lens, it often happens that, after the removal of the lens, a secondary cataract develops through subsequent thickening of the capsule of the lens, which makes further operations necessary. Naturally this cannot be done without injury

to the vitreous. There is no doubt that eyes operated upon for myopia are especially prone to develop detachment of the retina, and the patient's attention should be called to all the possibilities of disaster before the operation, and especially should it be stated that the operation is no guarantee against the serious intraocular changes that usually occur sooner or later as a consequence of the high grade myopia.

Discission is also used for the **removal of partial cataract.** In this latter variety, besides discission for removal of the lens, optical iridectomy must also be considered.

Discission for the Removal of Totally Opaque Lenses.—In congenital total cataract, discission is the only safe operation. Linear extraction is recommended only in patients of relatively advanced age and considerable intelligence, so they may be relied upon to remain quiet during and after the operation. On that account, in children we are accustomed to perform discission, as no extreme precautionary measures are demanded and there is ample time to wait until spontaneous absorption of the lens has taken place. The latter progresses usually promptly and completely in young patients. Occasionally it may be necessary to perform discission a second or even third time. Not infrequently after discission of even shrunken cataracts in children, an **increase in intraocular pressure** develops, which usually disappears, however, within a few days by the use of eserin and cold compresses. Only in rare instances will puncture of the cornea be necessary and the incision should not be longer than 2 millimeters at the most, so that danger of prolapse of the iris may be excluded.

As already noted, in some cases of congenital complete cataract in children, there is a greatly **shrunken lens**, so that in the course of discission after dividing the membrane, which consists of the anterior and posterior capsule with remains of slightly clouded lens, a black space immediately makes its appearance.

In **total cataract of young adults** the operation giving the most rapid results is **linear extraction.** We usually employ it in patients over the age of 12, but even in these cases **discission** followed eventually by **puncture of the anterior chamber** may be given preference. As the cataract in such eyes is often a complicated one, it may happen that the fluid vitreous escapes from the wound as soon as the incision has been made with the lancet. In this event a supplementary discission of the capsule of the lens must suffice, as it would be impossible to remove by massage the lens-masses from the eye.

OPTICAL IRIDECTOMY.

The indications for optical iridectomy are as follows: In soft lenses, with perinuclear opacities which only slightly interfere with visual acuity, it is best not to operate at all. In all other cases the tests should be made with the ordinary size of the pupil and afterward with fully dilated pupil. If the vision is improved by the dilatation of the pupil—in cases in which the diameter of the central disc-shaped cataract is a small one—and is brought to a degree suitable for the necessities of the individual concerned, i.e., at least a third of the normal acuity, this degree of sight can be obtained permanently by an optical iridectomy, whereby the patient has the advantage of still possessing the lens and with it the power of accomodation. In such case, the coloboma is best made below and to the inner side.

If, however, the improvement in vision following dilatation of the pupil is not sufficient, discission of the cataract is indicated. By this means the opacity can be completely removed, and the visual power returned to its normal range. The patient, of course, is forced to wear permanently strong convex glasses. In the greater number of cases of perinuclear cataract the latter operation is indicated, and in a much smaller number, iridectomy. The objection made against iridectomy that the cataract will probably become progressive and lead to total opacity of the lens, thus rendering the operation valueless, is, however, not sustained.

The technic of optical iridectomy differs from that of iridectomy for glaucoma not only in the method of incision but also in the type of excision of the iris. As the purpose of optical iridectomy is to alter the position of the pupil slightly, only that portion of the iris which borders on the pupillary margin should be excised. As the periphery of the iris must be preserved for optical reasons, the incision is placed in the limbus or a little to its inner side in the cornea. Otherwise, essentially the same details are followed as in iridectomy for glaucoma. The incision is made with the lancet, except in cases in which a shallow anterior chamber, for example, one the result of an anterior synechia, makes the use of the Graefe knife necessary. Whenever possible, the coloboma is placed to the inner and lower side, as experience shows that this position gives the best optical results. Very often, however, another portion of the cornea must be selected, as the remainder of the corneal surface has lost its transparency because of extensive opacities. Of course, it is readily understood

that care must be taken that the coloboma is not entirely covered by the upper lid. If in a one-eyed individual only the part of the cornea covered by the upper lid remains transparent and is suitable for an optical iridectomy, nothing remains but to produce a permanent depression of the eyeball by tenotomizing the superior rectus, so that the coloboma will lie uncovered in the palpebral fissure.

The iris is withdrawn with the forceps in the same manner as previously described. It is sufficient, however, to draw out the smallest possible fold and to cut off the tip with the blades of the de Wecker's scissors held perpendicular to the corneal incision. In this manner, a coloboma limited to the central part of the iris is produced, which at once enlarges considerably by retraction of its margins.

Precorneal iridotomy is an operation to obtain a smaller coloboma. In this operation, after the lancet-incision has been made, the iris is seized at its pupillary margin and drawn out of the wound. A small radial incision is made in the pupillary margin, after which the iris is replaced. As both ends of the sphincter retract, the cut turns into a coloboma of such a size that it is nearly impossible to recognize whe her it has been produced by an iridotomy or an iridectomy. As, however, this precorneal operative method has undoubted **disadvantages,** the most important of which is the surgical uncleanness of the procedure, namely, replacing the iris lying in the conjunctival sac into the eye, the regular iridectomy is decidedly preferable.

The ideal indication for an optical iridectomy is when corneal scars cover the center of the pupillary area. In order that we should not be disappointed by the actual results of an optical iridectomy, a **careful examination of the cornea** with the magnifying lens, to ascertain the condition of the so-called transparent parts of the cornea, is particularly demanded. Delicate diffuse opacities will frequently be found in those portions which were judged to be of perfectly normal transparency when examined with the naked eye. Not until the iridectomy is completed, are the corneal opacities easily visible against the black background, and they then often seem quite intense, while previously they entirely escaped the notice of the less careful observer. In making an examination with the magnifying lens, not only those portions of the cornea must be looked for which are at the same time the most central and transparent, but also we must take into consideration the areas where the opacity contrasts most sharply with

the surrounding parts. The sharper the margin, the denser the opacity; the broader the remaining transparent border, the better the outlook for a good result.

Recourse to an optical iridectomy should not be had too early in cases of corneal opacity. Opacities resulting from deep-seated keratitis, especially after parenchymatous keratitis in young people, often clear up slowly after many months. On the other hand, not much clearing up of scars after severe ulcerative processes in adults, should be expected. The cases particularly suitable for an optical iridectomy are those in which the opacity has resulted from a well-circumscribed area of disease (especially from ulcus serpens, infected wounds, etc.) while the rest of the cornea has remained approximately well. Conditions for a good result are much less favorable when the opacities have resulted from deep corneal inflammations, because the cornea is usually so affected that delicate, grayish, indefinite areas are found throughout its entire surface. The optical iridectomy, therefore, improves the vision but little, even when the pupillary area of the cornea is affected by a rather dense opacity. It must be remembered that the diffuse haziness of the peripheral portion of the cornea often causes marked disturbance of vision.

In any event, an exact determination of the visual acuity after painstaking correction of the errors of refraction (especially astigmatism) by the use of the stenopaeic disk is necessary. For this purpose, Fritsch, of Vienna, has constructed a **movable stenopaeic disk,** which may not only be placed into the various meridians by merely turning it, but can be easily shifted into a horizontal and vertical position. At the same time it is lodged in such a frame that it can readily be adjusted to any pair of spectacles. As often only a certain definite position of the slit gives the patient a substantial improvement in vision, the ordinary examination, with the trial frame commonly found in the test-case, does not serve the purpose. The tests with the disk should be carried out by adjusting it to the glasses which the patient is constantly wearing. For this purpose, we determine first as well as possible on the naked eye of the patient, the lens that gives him relatively the best vision for near work and for distance. Not until the patient has received the prescribed lenses from the optician, is the position of the stenopaeic slit determined by attaching the instrument to them. The position in which the optician has to place the stenopeic slit on the glasses, is then readily decided. This

accurate procedure is of the greatest importance, especially for those patients who are dependent upon one eye. The improvements occasionally produced by application of the stenopaeic disk are quite marked, and not infrequently the vision can be increased from finger-counting at 2 meters to 6/24 or 6/18, thus making possible reading and writing.

As already stated optical iridectomy is usually performed in cases with dense central corneal opacities rather sharply defined from surrounding healthy cornea. Before deciding on the operation we must first determine provisionally the effect of an optical iridectomy by dilating the pupil with atropin. **Artificial mydriasis,** however, cannot be exactly compared to that produced by an optical iridectomy, as atropin dilates the pupil symmetrically; but the operator learns from such an examination that in complete absence of improvement from uncovering a portion of the pupil behind a less clouded part of the cornea, a satisfactory result cannot be expected from an optical iridectomy. Moreover, if the patient's vision is lessened by dilatation of the pupil, a permanent reduction in his sight will follow by performing an optical iridectomy, as it is just in such cases that the impairment of the sight is dependent upon the irregular diffusion of the rays of light. It happens not infrequently that persons with diffuse corneal opacities see much better with a contracted pupil (comparable to a stenopaeic disk), than with the pupillary orifice widened.

Frequently, also, it is necessary to decide whether it is not possible to improve the vision by **tattooing of the cornea,** with or without subsequent iridectomy. In such cases it is recommended to tattoo the corneal scars provisionally as it were, by applying a piece of fine silk paper, absolutely black in color and cut as to exactly fit the opacity in the cornea. This paper adheres readily and makes possible a test of the visual power for comparison with the earlier test. In order that the piece of paper can be applied, the cornea should be rendered anesthetic by the use of alypin, which unlike cocain has no influence on the pupil, so that there is no artificial dilatation to interfere with the examination.

On the whole **the results of optical iridectomy** in corneal opacity are only moderate, and the cases suitable for the performance of this operation are relatively few. The beneficient **clearing effect** on corneal opacities which has been ascribed to iridectomy depends probably only upon a delusion, occasioned in eyes in which surgical inter-

ference was undertaken too early. Optical iridectomy gives much more favorable results in central lenticular opacity, that is, large central capsular cataract and especially in large lamellar cataract in which the opacity is sharply defined and has a small diameter.

Exudates, such as the connective-tissue membranes in the pupillary area following iritis, also afford an indication for optical iridectomy. Of course, due consideration must be given to the usually existing adhesions of the iris to the capsule of the lens resulting from the iritis, and a broader iridectomy performed in order to prevent a later rise in pressure. It must also be remembered that the result can be nullified by the pigmented layer of the iris-membrane adhering to the capsule of the lens and covering the coloboma.

CHAPTER XIV.

SECONDARY CATARACT. IRIDOTOMY. LINEAR EXTRACTION.

DISCISSION IN SECONDARY CATARACT.

As a secondary cataract forms the only septum between the aqueous and the vitreous chambers, discission cannot be performed without some injury to the vitreous, which always should be as little as possible. In other details the operation is done in the same manner as already described, and here also the pupil must first be widely dilated by atropin; a good side illumination from the lamp is important, especially in those cases with a glassy membrane in which the pupil occasionally appears quite black. If after the first incision a free space is noted at once, the needle must be withdrawn. Only when the first cut is without result is a second or third made in different directions, never penetrating the vitreous body deeply.

Complications.—If the pupil is held by posterior synechia, so that dilatation by atropin is impossible, the operation becomes somewhat more difficult, although an injury to the iris can be averted in consequence of the great depth of the anterior chamber.

If the membrane is tough, and has become adherent to the margin of the pupil, it may evade the needle and be pushed back under marked pulling of the iris, even producing laceration into the attachment of the iris (iridodialysis); or it gives way to the knife by detaching itself from the iris at one point and becomes pressed backward like a lid, returning quickly to its original position in the pupil when the needle is drawn forward, so that the result of the operation is frustrated.

If we fail to incise the membrane, it is useless to repeat the foregoing maneuvers, but resort should be had to a **discission with two needles** (**Bowman**). In this procedure one needle is introduced from the outer and the other from the inner side of the cornea, the needles crossing so that the point of the former lies near the inner margin of the pupil, and that of the latter near the outer margin. By raising the handles, the needles are moved in opposite directions and accomplish a tearing asunder (**dilaceration**) of the membrane. **Combined**

discission with one needle entered through the cornea and the other through the sclera may also be of advantage.

The operation with the needle is suited for cases in which the secondary cataract consists only of the capsule and the remnants of the lens. But if the membrane contains a layer of **connective-tissue, following an iridocyclitis** after a cataract-extraction, the needle is not sufficiently strong to freely divide it. In such cases it must be replaced by the **v. Graefe's knife** and the operation is then called **capsulotomy,** or, if at the same time some iris must be cut into, **iridotomy.**

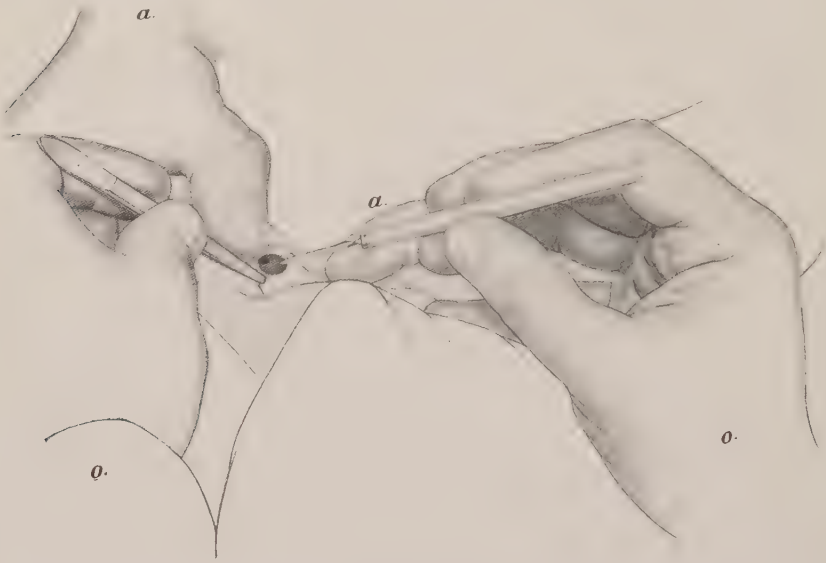

FIG. 90.—Iridotomy. The pupil is displaced upward by the scar resulting from the cataract operation, and is obstructed by a membrane. The patient is looking well upward; the eye is fixed at the side. The von Graefe knife, directed obliquely upward, is introduced into the cornea in the vertical meridian rather close to the lower limbus; the edge of the knife is directed backward.

The application of **iridotomy** may best be illustrated by a typical case. If, after an extraction with loss of vitreous, the pupil is drawn upward into the region of the dense scar and closed by a membrane consequent upon an iritis, the accompanying picture (Fig. 90) may be seen. Before any operative procedures are undertaken, it is necessary to make sure of good light-perception and projection, and also to wait until the inflammation of the eye has completely subsided and the irritation of the eyeball, manifested by the appearance of mild ciliary injection, is no longer occasioned. The

contemplated operation must accomplish two purposes, namely, to clear the pupil and to alter its position, so that it will come to lie behind the center of the cornea. It is not sufficient, therefore, to simply cut the membrane in the pupil, but the incision must extend through the iris and the dense fibrous membrane which lies behind it. For this purpose the cornea is penetrated below by a sharp Graefe's knife, the cutting edge of which is backward while the point is directed upward toward the pupil A vertical incision (Fig. 91). from above downward is made through the pupillary membrane and the iris, producing a vertical fissure which extends to below the center of the cornea. Only a very **sharp knife** will divide the membrane without pulling on the iris. Iridodialysis may occur if the membrane together with the attached iris evades the knife and is pressed backward. It is frequently observed that the dense membrane is readily divided, while the delicate tissue of the iris escapes the knife, resisting all attempts to incise it.

FIG. 91.—Incision in iridotomy.

After the incision has been completed, the knife is withdrawn and **pressure** immediately exerted on the eye through the closed lids by means of the finger, and a **pressure-dressing** applied at once. A firm bandage is **of the greatest importance in preventing hemorrhage,** which can occur not only from the cut vessels of the iris, if the latter has been incised, but also from division of the newly formed vessels found in the dense fibrous secondary membrane. Such hemorrhage would make the entire result of the operation doubtful and in most cases render it worthless. From extensive experience we know how difficult of absorption is a hemorrhage in the anterior chamber in eyes affected by a chronic iridocyclitis. If after many weeks the blood gradually disappears, it will usually be found that the clear space obtained by the operation is again closed by a fibrous membrane formed by organization of the clot. We are accustomed to remove the pressure bandage after six to eight hours, and to replace it by an ordinary protective dressing. By this time a sufficient closure of the injured vessels has taken place, and a secondary hemorrhage need not be feared. The many published bad results of the iridotomy just described, can usually be traced to neglect of the proper procedures for the prevention of hemorrhage.

The depth of the anterior chamber is not decreased by iridotomy, and a prolapse of the vitreous is impossible. The dressing may be

removed as early as the day after operation, and rest in bed is not necessary. Provided that no serious intraocular conditions exist (dense vitreous opacities, retino-chorioiditic areas, etc.), vision may become good. However, these complications are not infrequent, and the unsatisfactory results must not be attributed to the operation.

A **vertical incision** gives the advantage of cutting approximately parallel to the fibers of the iris without seriously injuring any of its vessels. The disadvantage of making the incision in the direction of the fibers of the iris arises from the fact that the cut shows no tendency to gape and sometimes exists only as a fine line, which soon closes completely through the accurate application of the wound-edges. If a **horizontal incision,** running transversely to the direction of the iris-fibers, is used, we are able to make it at any height desired (therefore, exactly behind the center of the cornea), and in addition produce a broader gap through retraction of the iridal tissue. A horizontal incision, it is true, divides many more of the blood-vessels of the iris, and, therefore, the pressure-dressing must be applied to the eye with special rapidity after the incision has been made. If, however, as is not infrequently the case, the iris has undergone a fairly high degree of atrophy, a large number of the iridal vessels will have been obliterated and the injury to them is of but little importance.

Should the result be unsatisfactory, there is no objection to an early **repetition of the operation,** provided that the eye is not much irritated.

The foregoing method of iridotomy is the only operation we employ in cases of complicated secondary cataract. Its superiority over the various other operations recommended (discission after de Wecker, etc.), consists in not opening the anterior chamber thus making a loss of vitreous impossible, in its greater rapidity, in the careful handling accorded to the iris, and in the almost invariable satisfactory result, if such an issue of the operation is at all possible.

Discission through the sclera (Fig. 92).—This operation is adapted only to **secondary cataract.** The needle should be stronger than that ordinarily employed for discission through the cornea. By entering through the sclera, there is the advantage of being able to use more force in dividing the membrane than is possible by the operation from the front.

To avoid various unpleasant **complications,** the perforation with the needle must be made posterior to the ciliary body, that is, at a

distance of at least 6 millimeters from the limbus and either above or below the horizontal meridian, so as not to injure the posterior long ciliary artery. It is easier to enter at the outer and inferior side, while the patient looks upward and inward, and the eye is held in this

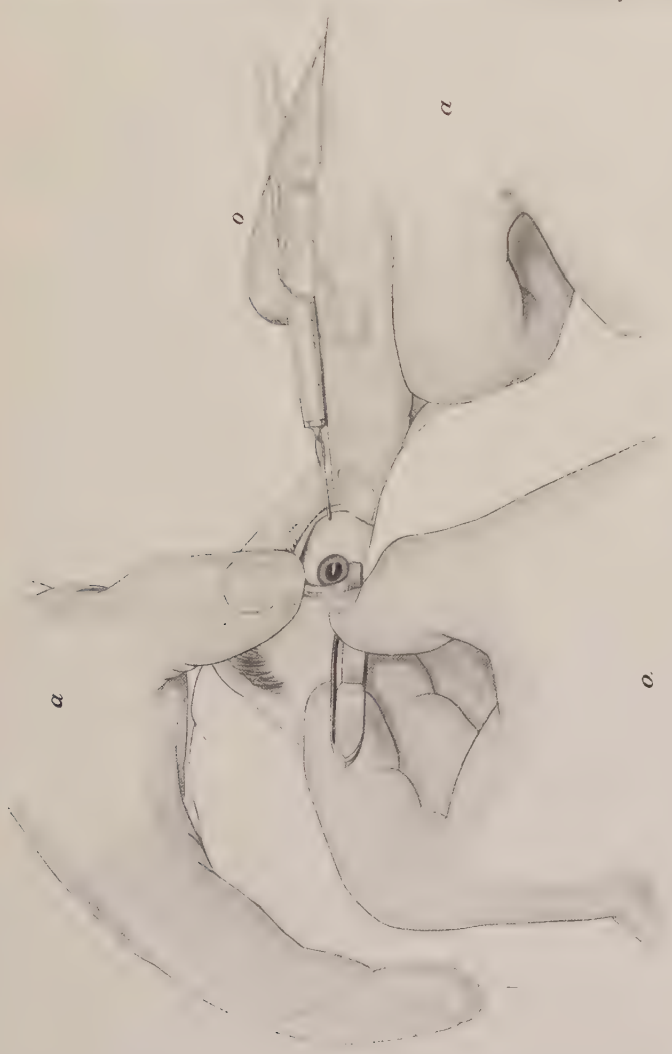

FIG. 92.—Discission through the sclera in the left eye. The discission-needle is introduced from the outer and lower side and pushed forward through the sclera, at a distance of more than 6 mm. from the limbus. Secondary cataracts are pierced so that the point of the needle appears in the anterior chamber. Lastly, the membrane is divided by bringing the needle into an erect position.

position by forceps. The needle is directed forward and pushed through the membrane in the pupil so that the point appears in the anterior chamber (Fig. 92). By elevating the handle of the instrument the membrane is divided. In order not to injure the vitreous more

than is necessary, as few cuts as possible are made. If, after the first cutting movement, a black space is seen to appear in the membrane, the needle is quickly withdrawn from the eye. Only in case the first incision fails to produce a free opening, and simply depresses the membrane so that it springs back again into the pupil, must a second or third attempt be made to incise it. The injury to the vitreous incurred by this method is no greater than when the operation is performed through the cornea. In all cases of secondary cataract, injury to the vitreous cannot be absolutely avoided. A great advantage of this operation is that the surgeon is able to move the needle in a larger area of excursion than when the needle must be pushed through the cornea into the deep anterior chamber in a perpendicular direction. The latter procedure leaves very little freedom of motion to make the incision. After discission through the sclera, complications such as **increase of intraocular pressure** and **cyclitis** frequently occur. The former usually disappears within a few days under the use of eserin and cold compresses. In most cases the cyclitis is also a transient phenomenon.

LINEAR EXTRACTION.

Linear extraction is an operation employed for the removal of **soft cataracts.** The thirty-fifth year is approximately about the upper age limit at which this operation can still be performed.

After dilatation of the pupil by atropin, a **linear incision** about 6 to 8 mm. long is made with the lancet *below* and exactly at the limbus. Sitting to the right of the patient the operation is performed on the right eye as well as the left with the right hand. Essentially the same rules described for the iridectomy incision, are the guide in holding the lancet (Fig. 93). It is first applied rather perpendicularly, and as soon as the point has perforated the limbus, the blade is turned parallel to the iris (Fig. 94), and without either forward or backward pressure, pushed in until the incision has reached the desired length. If the iris is well retracted, it is not exposed to any danger of injury. As with all cuts which open the anterior chamber, the instrument must not stop in its progress, otherwise escape of the aqueous humor would render impossible a further lengthening of the incision. The eye is held fast at any suitable point. As the operation is performed without iridectomy, the point at which the eye is grasped with the forceps for the purpose of fixation plays no rôle. The lancet is slowly withdrawn

from the eye so that the aqueous humor escapes gradually. At the moment the anterior chamber collapses, the pupil frequently becomes suddenly narrow. In other cases, however, the iris is floated into the wound by the aqueous humor.

The second step of the operation consists in **opening the lens-**

FIG. 93.—Linea extraction in the right eye. The operator's left hand fixes the eye with a pair of forceps, above at the limbus, while with the right hand he applies the lancet almost vertically below, exactly at the limbus. The pupil is dilated by atropin. A diagram showing the position of the incision in this operation may be seen in the sketch on glaucoma (Fig. 96).

capsule. Here also we prefer the use of the **capsule-forceps** for the reasons mentioned in Chapters XI and XII. They must be slightly raised after they have entered the pupil, so that the posterior untoothed part of the closed blades does not seize the iris. With a relatively short incision and a narrow pupil it may be difficult to use the forceps without untoward results, and the pointed tenaculum, which must always be

at hand, is to be employed to incise the capsule several times. In so doing the tenaculum must be applied without making pressure, in order to avoid displacement of the lens.

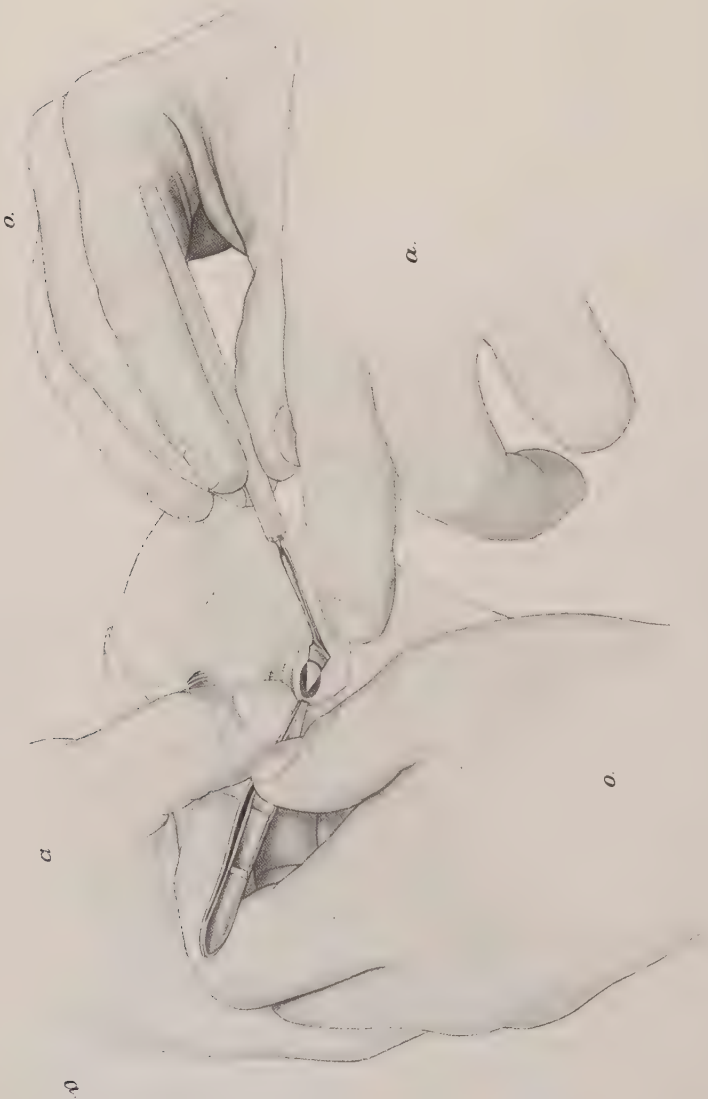

FIG. 94.—In the second part of the incision, the lancet is turned over and has penetrated far upward. The incision lies exactly at the limbus.

The third step of the operation, the **removal of the lens,** is accomplished easily. If the cataract is soft, it suffices to merely depress the scleral wound-margin slightly by means of the spoon, in order to

allow the soft mass to slide out through the gaping wound. If, at the same time, the cataract is gently stroked from above downward with another spoon against the cornea (Fig. 95), the escape of the lens-substance will be rendered easier. Occasionally, after the pupil has become black, new opaque particles appear from above and behind the iris as the result of this gentle massaging. These must be removed through the wound by further massage.

Difficulties in the removal of the lens-substance occur only when the lens unexpectedly contains a fairly **large nucleus,** which presses against the wound and cannot be forced through safely, since no great force dare be used in the massaging. A rather dense nucleus may be found even in young people. In these cases it is better to lengthen the incision at one or both ends by means of the scissors, allowing the nucleus to escape easily, rather than to run the risk of a prolapse of the vitreous by applying too strong pressure. A **careful replacement of the iris** concludes the operation.

In this type of operation **care of the iris** requires the most careful consideration. This delicate membrane must not be injured either during the incision or in opening the capsule of the lens, nor disturbed too much in massaging out of the cataractous mass with the spoon. Care should also be taken to avoid injury in replacing it with the spatula. A torn iris may give rise to most unpleasant sequelæ, by shrinking or by adhering to the corneal scar. If the iris has been considerably injured it should be excised. The resultant coloboma lying exposed in the palpebral fissure, however, causes annoying visual disturbances. As the operation usually passes off smoothly, the incision below is preferable, because the patients more readily look upward, and so freely expose the field of operation. If performed near the specified age-limit, it is better to make the corneal incision above, so that in the event of a large nucleus the wound can be lengthened and the iris, should it prolapse, excised.

After the operation a **dressing** is applied and the patient put to bed. It is not necessary to instil eserin as it would have no influence, the iris being under atropin. If no complications have occurred, the dressing may be discarded after six days.

In old and complicated cataracts the lens-capsule is thickened, and it may happen that the **lens together with its capsule** is pulled out of the eye with the capsule-forceps. Occasionally such an operation is performed in blind eyes, but only for cosmetic reasons. In this

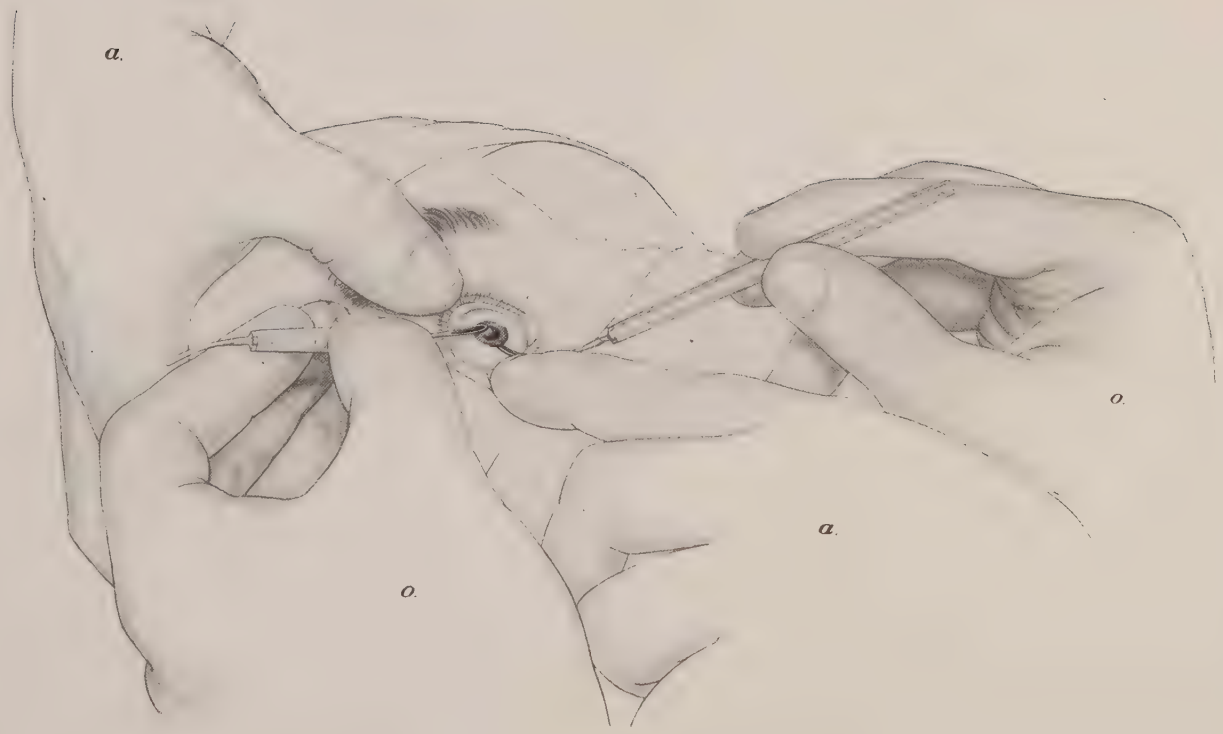

FIG. 95.—After opening the capsule the soft cataract-remnants are massaged out of the eye. A spoon held in the right hand of the operator depresses the scleral wound-margin somewhat, thus causing the wound to gape, while with another spoon held in his left hand he makes stroking movements over the cornea from above down.

procedure there is always the **danger of prolapse of the vitreous.** However, as the vitreous rarely has its normal consistency, but is fluid and the eyeball soft, the wound shows no tendency to gape, and the iris usually retains its normal position. Much more unpleasant is prolapse of vitreous of normal consistency during the course of a linear extraction. In this instance, not only is the further removal of the soft lenticular mass prevented, but no replacement of the iris can be attempted, and the pupil remains permanently distorted. Moreover, the wound frequently gapes, and has its healing process interfered with by the lower lid pressing against it during the ocular movements. Application of a suture to produce coaptation of the edges of the wound may become indispensable.

Linear extraction near the lower age-limit has already been discussed.

CHAPTER XV.

GLAUCOMA.

IRIDECTOMY.

The incision for iridectomy in glaucoma does not penetrate the sclera at the limbus, but $1\frac{1}{2}$ mm. behind it. The line *c d* (Fig. 96) shows the direction of the penetration of the point of the knife, the lancet applied vertically to the sclera. This, however, is only possible if the angle of the anterior chamber is deep. If the chamber is shallow, or if the iris-root is in contact with the posterior wall of the

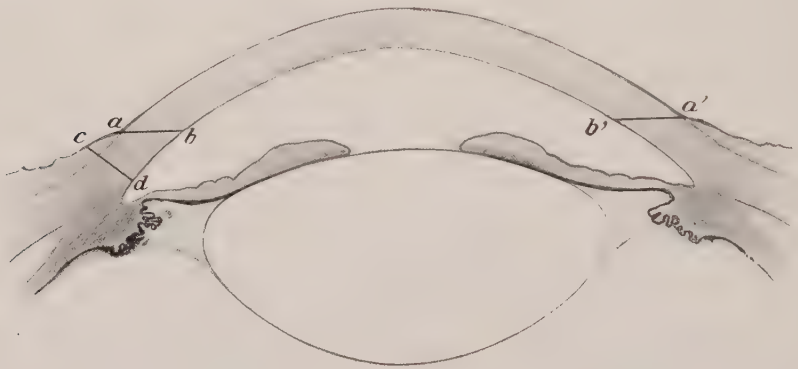

FIG. 96.—Anterior portion of the eyeball in cross-section to demonstrate the relations in position of the angle of the chamber and limbus (enlarged). The limbus reaches about 2mm. further forward than is represented by the situation of the angle of the chamber, a and a′; limbus. ab and a′ b′; position for the incision of the extraction. Graefe's knife, which in cataract incisions is inserted just at the limbus, at a, perforates the posterior wall of the cornea at b. In order that the knife shall come out exactly again at the limbus at a′, the counterpuncture must be begun already at b′, that is, at a point which to the operator seems to lie about 1 mm. from the limbus, in the direction toward the cornea.

cornea, an injury to the iris would be unavoidable. Moreover, as in such a puncture the inclination to bring the lancet into the plane of the iris is very strong, it is recommended not to apply it too vertically against the sclera when making the puncture.

The Incision with the Lancet.—As it is the intention to extirpate the iris at its ciliary attachment the incision must lie in the sclera at a distance of about 1 to $1\frac{1}{2}$ mm. from the limbus, the instrument being carried through the angle of the anterior chamber, the relations of which,

as pointed out in the operation for cataract, render clear the situation of the scleral incision. If, therefore, the incision is made with the lancet, its point must be placed against the sclera at the distance named, the blade forming an angle of about 45° to the curving of the sclera (Fig. 97). The lancet is held in the right hand between the

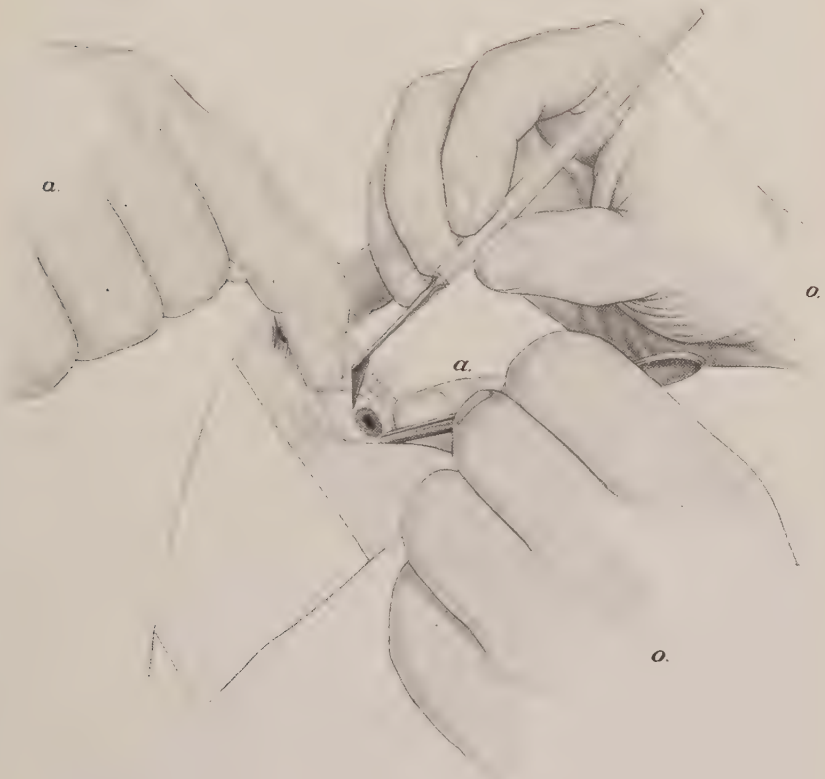

FIG. 97.—Iridectomy for glaucoma in the left eye. Beginning of the incision. The assistant fixes the upper lid with one finger of his right hand in such a manner that the operator is not interfered with in the second act of the incision, when the position of the lancet is changed. The lancet is applied slantingly against the sclera at a distance of at least 1 mm.

thumb and first and second fingers, while the little finger is steadied against the head of the patient, the operator sitting on the right side of the patient. The eyeball is fixed below, exactly in the vertical meridian, as in the operation for cataract, so that the coloboma is directed upward. An undesirable laterally situated cut and correspond-

ing coloboma is the result of rotation of the eye if the forceps holds the ball at the side. The patient himself should look well downward during the incision. In the slanting position the point of the lancet is made to penetrate the sclera.

Immediately after the perforation the lancet is turned so that the

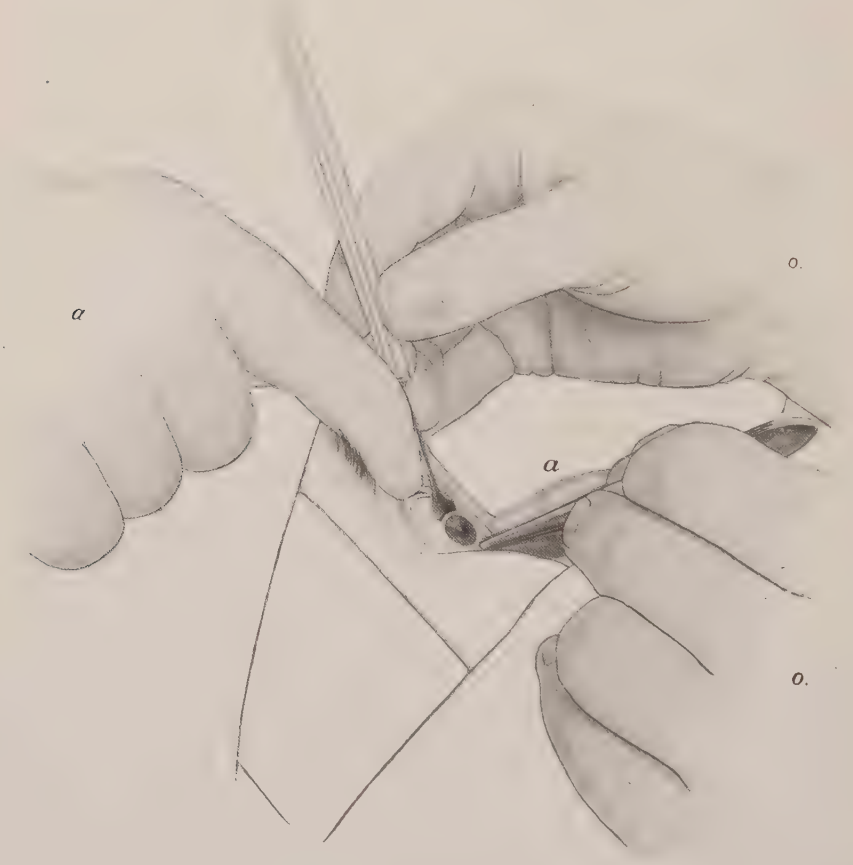

FIG. 98.—The position of the lancet is changed to the plane of the iris and is held so that the incision on all sides has the same distance from the limbus. The lancet penetrates further downward, than is shown in the figure.

surface of the blade is parallel with the iris (Fig. 98). The turning of the lancet at the proper time is the most difficult part of the incision, and can be told only by the sense of touch, as after completion of the perforation the resistance of the ocular tunics disappears. If the direction of the knife is changed too soon, the cut is made irregularly,

and, what is still worse, placed too far forward into the cornea, and the internal opening, instead of being placed into the angle of the chamber, is found nearer the cornea. After the knife enters the eye, and its surface is parallel with the iris, it is pushed downward without interruption, until the point passes the lower border of the pupil, and the cut is as large as needed (Fig. 100). In this maneuver the point of the lancet naturally approaches near to the posterior surface of the cornea. During the incision the lancet must not be pressed backward against the sclera, as the wound will gape and the aqueous humor flow away, thus making prolongation of the incision impossible, as through it the iris and lens would most likely be injured. As in all other incisions which open the anterior chamber, any withdrawal of the instrument while making the cut is absolutely forbidden, as this would frustrate the further progress through the escape of the aqueous.

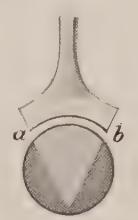

FIG. 99.—The lancet is pushed far down. The solid line ab denotes the position of the cut.

The incision must be made parallel to the limbus. (Fig. 99 *ab*). For this purpose the lancet itself must be held parallel to the same. If, for example, one edge of the knife is turned slightly forward, the cut on this side will not remain at the same distance from the limbus at which the point of the lancet was first placed, but will deviate forward into the cornea. Indeed, the difficulty of the incision with the lancet lies in the fact that the eye of the operator must at the same time control the point of the instrument penetrating more and more downward, and also the appearance of the cut above at the limbus. When the lancet has entered far enough downward, and the incision, therefore, has been made long enough, the instrument is slowly withdrawn from the eye, with the blade parallel to the iris.

Especially the point must on no account be turned backward, as otherwise the lens-capsule will be injured while passing the pupil. One can avoid the latter altogether by a slight sideward movement of the point of the lancet and thus carry it upward in front of the iris. In withdrawing the lancet we do not increase the length of the incision, as practised by some operators, by pushing the lancet somewhat forward along the side of the limbus. During the withdrawal of the knife the aqueous humor may rapidly escape, and float the iris forward with it, or the flow may be slow; the pupil then remains round.

The Incision with the Graefe Knife.

As regards fixation of the eye and the employment of the right or left hand, the same rules apply as in the operation for cataract, the operator sitting at the right side of the patient. Only on the right eye, if the anterior chamber is very shallow, it may be preferable to operate from behind, as in this position the right hand can be steadied on the head of the patient better than the left when operating from the front. The length of the incision should be the same as when the lancet is used, about 8 mm. To obtain a sufficiently peripheral position, the knife-point is entered in the sclera at a distance of $1\frac{1}{2}$ mm. from the limbus. It is passed through the sclera approximately parallel to the plane of the iris. If held more upright against the sclera, an injury to the iris, and indeed even to the lens, is easily incurred. After the point of the knife has appeared in the angle of the chamber, the instrument is pushed forward to the outermost part of the opposite angle, always remaining in front of the iris to avoid the pupil, and the counterpuncture is made $1\frac{1}{2}$ mm. from the limbus. The knife is carried upward with a sawing motion, during which it is held in a plane parallel with the iris, so that the incision remains at a uniform distance from the limbus throughout. Not until the knife has arrived beneath the conjunctiva, is its cutting edge turned forward to form the short conjunctival flap, as in the cataract-operation.

The incision must be made with the Graefe knife: 1. If the anterior chamber is *very* shallow. 2. If the pupil is dilated. 3. If the cornea is so opaque as to prevent the operator's view of the path of the knife. 4. In restless patients. Before an iridectomy for glaucoma the pupil should be contracted as much as possible by energetic use of eserin, which, however, is often without effect when the pressure is considerably increased and advanced atrophy of the iris is present. Alypin is used for anesthetization, instead of cocain, because the former produces no dilatation of the pupil. The lack of vaso-constrictor influence can be remedied by the stimultaneous administration of adrenalin.

The incision with the lancet has the **advantage** that its edges are smooth and easily apposed, so that after a few days the wound has closed faultlessly, in fact, the scar is often scarcely visible. The incision with the knife is more inclined to gape, and, on account of its irregular edges, does not heal so promptly. But this factor may be considered as an advantage in eyes with an increase of pressure, inasmuch as fluid will ooze out more easily and for a longer time through a wound

which does not close rapidly than through one which heals promptly and solidly.

There are a number of **important disadvantages of the incision with the lancet.** The lancet is an extraordinarily sensitive instrument. The previously faultless point may be injured even by simple boiling. Much pressure is not permissible while perforating the sclera with the lancet. A good cutting point glides easily into the sclera without much resistance. If, however, the point is slightly bent or not sufficiently sharp, it would be a mistake to try to make the perforation with force. For, at the moment when the damaged point has penetrated, and the good cutting lateral portions of the instrument are engaged, the instrument suddenly slips forward and injury to the iris and lens is scarcely avoidable. The same accident may take place also while making the incision with the lancet, when a nervous patient suddenly makes a brisk movement with the eye or head. The knife is undoubtedly much less dangerous, especially for the beginner, and a more peripheral position is more easily attained with it than with the lancet. On this account the lancet is only used in those cases in which the anterior chamber is not too shallow, and those with a contracted pupil, when quiet behavior of the patient is probable.

While the performance of the incision with the knife lessens somewhat the danger of injuring the iris and lens through too rapid and too deep penetration, it occasionally leads to the opposite error—the **intralamellar incision.** The experienced operator at once recognizes the false position of the knife through the persisting resistance, which otherwise disappears as soon as the anterior chamber is opened. Also, a retraction of the cornea is visible at the site of the knife, when it is being pressed backward slightly. As already stated, the cut may be repeated at once at the proper point, if the anterior chamber has not been opened, provided, however, that the aqueous humor is still there. In the latter case, nothing remains except to postpone the operation until the next day.

The excision of the iris is performed with the instruments already described in the operation for cataract—the iris-forceps and de Wecker's forceps-scissors. The iris-forceps are held in the left hand and introduced closed into the wound parallel to the iris until they reach nearly to the upper margin of the pupil. They are then opened widely and a fold of iris is drawn up and pulled out of the wound. The excision is then quickly completed with de Wecker's scissors,

which have been held ready. The iris-section is, however, essentially different from that in cataract-operation. As our object is not only to excise the iris close to its attachment, but also to remove as large a piece as possible, the scissors are now held parallel and closely to the wound (Fig. 100), which may even become slightly depressed by them, and the iris has to be severed by making two cuts. The right half of the iridal fold is cut through first, after which the rest of the iris, is drawn with the forceps still further toward the other angle of the wound, thus pulling still more membrane from the eye, and then the left half cut through. As the excision of the iris is ordinarily quite painful, it should be done as quickly as possible. The scissors, therefore, must be prepared and ready close to the wound as soon as the iris is grasped.

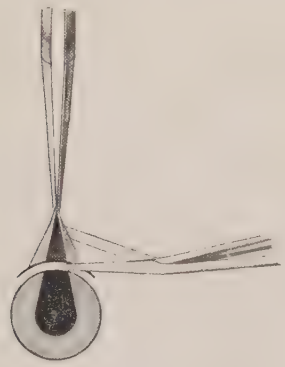

FIG. 100.—The iris drawn out from the eye is cut off near its attachment by the scissors, the blades of which are held parallel with the limbus.

The Reposition.—After the iris is excised, it lies in most instances in both angles of the wound or is, at least, squeezed into them. An accurate reposition is all the more important, because a healing in of the iris *in situ* would likely lead to a renewed attack of glaucoma. It is much more difficult to effect reposition than in the operation for cataract, but is accomplished in exactly the same manner (see p. 138). The greater difficulty is due to the relatively higher pressure which squeezes the margins of the coloboma into the angles of the wound more than in the cataract-operation, and, as the iris is frequently in a state of atrophy, it shows but little tendency to resume its normal position. Reposition is a very delicate operation, as the spatula occasionally injures the lens-capsule. It should, therefore, be the aim to avoid touching this membrane. The spatula must be withdrawn from the eye in the neighborhood of the coloboma, after the operator, coming from the angle of the chamber, has stroked the sphincter edges into their proper position. Care should be taken not to press the iris up again. Attempts at reposition are not be discontinued until after both sphincter-margins have been returned to their normal position. As in the operation for cataract, the last step of this procedure consists in attention to the proper position of the conjunctival flap.

The indications for iridectomy are primary glaucoma, as well as cases of secondary glaucoma which are not of a transient nature, as, for instance, increase of pressure caused by anterior synechiæ, exclusion of the pupil following iritis, luxation of the lens, cysts of the iris, beginning ectasia of the conjunctiva or sclera, etc.

The **complications** which may arise in the course of an iridectomy for glaucoma have mostly been described in the operation for cataract, and need only brief mention here. The most important are:

1. *Laceration of the conjunctiva* when grasped by the forceps.

2. *Intralamellar incision.*

3. *Transfixion of the iris* by Graefe's knife. If the anterior chamber is shallow, the point of the knife may catch in a protrusion of the surface of the iris and penetrate its tip. This piercing of a few fibers of the iris with the knife is of no significance, as they are always cut through during the continuation of the operation, so that the freed iris again resumes its normal position. As in all other incisions which open the anterior chamber, it should be considered the cardinal rule never to withdraw the knife with the intention of freeing it.

The escape of aqueous humor at the moment of withdrawal makes a continuation of the incision impossible. The only indication for the withdrawal of the knife is when the operator, while introducing the knife, gets in back of the iris. In this case, if the faulty incision were continued, even more extensive injuries to the iris and lens would occur than after immediate withdrawal of the knife. As the incision is relatively much shorter than that in cataract-extraction, and is ordinarily above the region of the pupil, "a falling of the iris in the way of the knife" is an extraordinarily rare occurrence in spite of the shallow chamber.

4. *Production of an Iridodialysis during the Incision with the Lancet.*—If the point of the lancet catches in the iris, the latter may be drawn down and thus torn off at its ciliary attachment. This unpleasant occurrence is usually followed by an intense hemorrhage, which will greatly impede the further course of the operation, especially as it is difficult to pull the severed piece of iris out with the forceps without endangering the exposed lens-capsule. It is safer to employ the blunt hook for pulling out the iris instead of the forceps.

5. *The possibility of injuring the lens* when introducing the lancet has already been considered.

6. *Incorrect position of the incision* is due to a faulty manner of

holding the knife (turning the cutting edge forward) or through improperly inserting the point of the knife. A cut directly forward against the cornea naturally lessens the likelihood of excision of the iris to its root. Especially to be avoided is too long an incision, which may be produced by introducing the knife too low down. The high intraocular pressure would cause the wound to gape and the lens to appear in the wound.

Complications in the Course of the Iridectomy Itself.—The excision of the iris for glaucoma is on the average much more **painful** than that done in cataract-extraction. The influence of the anesthetic is much slighter on account of the injection of the eye, and perhaps also because of the alteration in transfusion-conditions. It is our custom, therefore, after the incision to instil several drops of a sterile 3 per cent. solution of **cocain** upon the wound, which, by direct contact, appreciably reduces the sensitiveness of the iris. The extreme susceptibility of the iris to pain complicates the operation, as, during the excision, tearing loose of the membrane from its attachment, and even pulling out of a large piece, may occur if the patient suddenly gives a vigorous jerk, just as the operator takes hold of the iris with the forceps.

Especial care is required in using the **forceps** to bring the iris forward to prevent **injury of the lens-capsule.** They should be introduced into the wound parallel with the iris and pushed close to the margin of the pupil, but not brought within the pupillary space itself. If the iris has already floated into the wound, the forceps must not be pushed into the interior of the eye at all; but should lift up the exposed iris, which becomes plainly visible after the conjunctival flap has been laid back on the cornea. Should the patient not look well downward, the excision of the iris may become difficult and the danger of injury to the lens-capsule increased; especially if he keeps moving his eyes around, or suddenly looks up, while the forceps are in the eye. In such cases it is better to fix the eye with forceps, which ordinarily we avoid in doing iridectomy. Instead of the iris-forceps it may be necessary to draw out the iris with a **blunt hook** which has been bent in a suitable direction. It is self-evident, that we occasionally must be content with the excision of a small piece of the iris, the removal of a large one, under the circumstances, being inadvisable or impossible.

Iridectomy may be difficult if the **iris is atrophic** and so friable

that the forceps tear out at each attempt to grasp it. The iridectomy is also complicated in well-advanced glaucoma by the fact that the upper half of the iris is sometimes so small that it disappears behind the limbus. In such cases, we make the coloboma below, as the iris is ordinarily somewhat broader there. The disturbance to vision due to the uncovered coloboma is of no importance, as the eyes have already been seriously damaged by the glaucoma.

The earlier the iridectomy in glaucoma, the easier the operation. As long as the anterior chamber is not too shallow, and the iris almost normal, the production of a large coloboma is possible. As a result of the peripheral situation of the incision, the coloboma should reach to the attachment of the iris. Considered technically, the longer the operation is delayed, the harder it becomes and the less satisfactory the result. If the angle of the chamber has been obliterated by adhesion of the root of the iris; that is, if it is displaced further forward, the incision cannot be made as near as desirable to the periphery.

Hemorrhage may become a disturbing factor in iridectomy for glaucoma. It may occur during the performance of the incision, originating either from dilated conjunctival or anterior ciliary vessels or as a consequence of injury to Schlemm's canal. The anterior chamber becomes filled with blood so that the iris is hidden from view. At first we must try to remove the blood from the eye by stroking it out, assisting it to escape by slightly depressing the peripheral edge of the wound. Usually the blood reaccumulates quickly. It may be impossible, however, to remove the blood, as it becomes attached to the walls of the anterior chamber in the form of a clot. As the pupil cannot be seen, the lens-capsule is in danger during the pulling out of the iris. The presence of the blood also greatly disturbs the replacement.

Complications During Reposition of the Iris.—The greater difficulty in replacing the iris-margins in this operation as compared with that for cataract has already been mentioned, especially the possibility of injury to the lens-capsule. One may even be compelled to desist from the replacement if the patient cannot be induced to look downward. Fixation of the eye has always the great disadvantage that the wound is made to gape and increases the likelihood of an injury to the lens, the margin of which may present in the wound. The necessity of proper replacement need not be further enlarged upon. It must, however, be expressly pointed out,

that, when as the result of one of the margins of the coloboma growing fast to the wound a renewed increase in pressure is noted, no other procedure is indicated beyond the freeing of the adherent iris by operative interference. Neither a second iridectomy nor a sclerotomy nor any other similar operation fulfills the indication.

The liberation of attached iris is performed in the following manner: An incision is made with Graefe's knife, which is inserted at one angle of the scar, carried through the anterior chamber until it reaches the other side of the site of adhesion, and is then brought out as far in the periphery as possible. The incision is completed with sawing movements. Frequently the knife has already separated the iris from the scar, and the membrane assumes its proper position immediately after the incision has been completed. If this result is not secured, the iris must be brought out from the wound with the iris-forceps, and as large a piece as possible excised. The cut edges are then replaced. Because of the state of ocular irritation, this operation is often difficult of performance, but is usually followed by a favorable result. The blackish scar, which has been ectatic, soon flattens out during healing, and the increase in pressure does not recur.

This operation is also indicated in adherent iris after cataract-operations in which there has been an increase in tension. In order to prevent a gaping of the wound and a prolapse of the vitreous, it is recommended to leave a bridge of conjunctiva and then bring the iris out under it. By the same method one has to remove the so-called cystic scars after cataract-operations.

Prolapse of the vitreous is a relatively rare occurrence in iridectomy for glaucoma. It is most likely to happen in old absolute glaucoma, especially if there is ectasia of the sclera. The prolapse not only makes excision of the iris impossible, but also a reposition of its margins. Besides, the wound gapes because of the interposition of the vitreous, and, although an ugly ectatic scar is formed, it is one of the relatively good outcomes of the operation. In most instances renewed attacks of increase in pressure follow, which, on account of their painfulness, finally render enucleation of the eye compulsory. Occasionally the vitreous prolapse leads to a still graver complication, namely, **expulsive hemorrhage.** On account of the sudden decrease in pressure, severe hemorrhages under the chorioid occur, which is pushed forward with the retina and squeezed out of the eye through the wound. Particularly in the operations for old absolute glaucoma

is this accident seen. Such eyes must be immediately enucleated; otherwise weeks would pass before the eye atrophied and became quiescent. The bleeding which occurs with expulsive hemorrhage is usually very considerable, and to arrest it temporarily the application of a pressure-dressing is necessary.

Subluxation of the lens may occur in connection with its altered position following the opening of the anterior chamber and the escape of the aqueous humor. The lens then inclines forward, and its upper border tends to turn forward on account of the lessened resistance of the coverings of the bulb in the region of the wound. This presages a bad prognosis for the later behavior of the eye. The anterior chamber does not become re-established for a long time, intense attacks of renewed increase in pressure follow, and in spite of repeated sclerotomies and other operations such eyes are usually lost.

Cataract, which occasionally follows the operation, deserves special mention. Injuring of the lens, the danger of which has been frequently mentioned, occurs in the region of the anterior capsule, and if a careful examination is made, the scar of the capsule wound, from which the cataract had its origin, can always be demonstrated. The cataract does not always become complete, but may be confined either to a clouding in the neighborhood of the capsular wound, or to a stellar opacity in the anterior or posterior lamellæ of the cortex.

Occasionally after iridectomy for glaucoma there may occur a **spontaneous rupture of the lens-capsule** in the region of the equator. This is especially seen in cases in which, after completing the iridectomy, a subchorioidal hemorrhage produced an increase in intra-ocular pressure, by which the lens is displaced forward and its border presents in the wound. In this condition the capsule, being deprived at this point of its protecting intra-ocular pressure, ruptures through the forward pushing of the lens-substance. As the rupture lies in the equator of the lens, *no capsule wound is seen by lateral illumination*, and the clouding of the lens begins in the posterior cortical substance. The lens-capsule may burst spontaneously over a wide area and the lens-substance with the nucleus be either discharged from the eyeball or become incarcerated into the wound (*Hernia lentis*), which remains highly gaping under the conjunctiva. Fortunately, such cases are rare. We must be prepared, however, for such accidents in operations on eyes with long-continued, high-grade increase of pressure, when the eye is of stony hardness, the anterior

chamber almost obliterated, the sclera becoming ectatic, the iris markedly atrophic and the eye itself painful. The operation often cannot be performed without a general anesthetic. If the eye is completely blind, enucleation should be advised.

CHAPTER XVI.

GLAUCOMA—(Continued).

ANTERIOR SCLEROTOMY (DE WECKER).

Anterior sclerotomy is done with a Graefe cataract-knife, and resembles the incision made for the extraction of a senile cataract, except that it is placed *more peripherally*. The opening into the anterior chamber may be made above or below, the eye being fixed

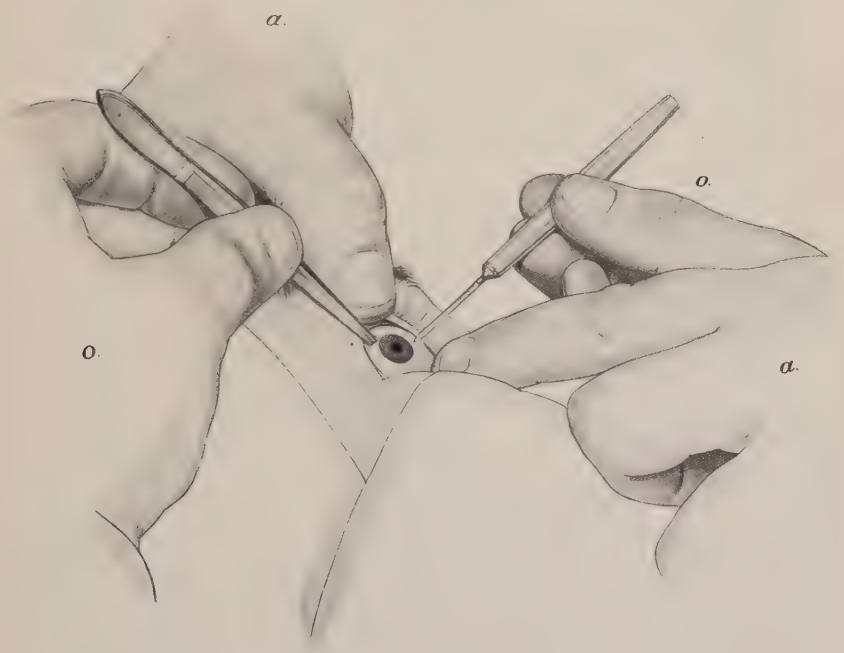

FIG. 101.—Anterior sclerotomy in the left eye, performed below. Beginning of the incision. The left hand of the operator fixes the eye, either laterally or above; the cutting edge of the knife is directed downward. The incision is begun at least 1 mm. away from the limbus in the sclera. The lower lid is drawn far downward by the assistant.

at such a point that the forceps will not be in the way of the knife. As the operation has for its object an incision into the angle of the chamber, the points of entrance and exit of the knife must lie in the sclera at least 1 to 1½ mm. from the limbus, according to the relations

of the parts already described. As the knife can be entered only from without, the directions given in the discussion of the operation for cataract as to the use of the right or left hand hold good here (Fig. 101).

As the anterior chamber is usually shallow in the eyes in which anterior sclerotomy is indicated, the performance of the incision is by no means easy. If the point of the knife is thrust through the sclera too vertically, the iris may be pierced and even the lens injured. For this reason, in the effort not to wound the iris, the knife is applied parallel to its surface. If its point is directed slightly forward, it is pushed between the layers of the cornea—an **intralamellar incision.** Frequently it cannot be seen that the knife is passing between the layers of the cornea, but the experienced operator detects the error because of the continued resistance, which disappears at once when the perforation is made properly. After the point of the knife has entered the angle of the chamber, it is slowly carried onward between the cornea and iris, until it reaches the angle of the chamber on the other side, where it is made to penetrate the sclera, reappearing at the same distance from the limbus as the first pucture (Fig. 102). The incision is continued with sawing movements as described in the operation for cataract.

FIG. 102.—Diagram showing the position of the knife in the eye during the incision of the sclera. It lies at least 1 mm. away from the limbus in the sclera.

In order, however, to prevent a prolapse of the iris, *the cut is not completed*, but a small bridge of sclera is permitted to remain; in other words, the knife is withdrawn from the eye before the incision is finished. But, as it is the intention to cut into the angle of the chamber of this portion too, the handle of the knife is depressed, *i. e.*, raised, while withdrawing the blade so that its point cuts through the angle of the chamber from within (Fig. 103). The length of the entire incision is somewhat less than that of the cataract-incision. We begin, therefore, about 3 mm. from the horizontal meridian, as seen in the illustration (Fig. 104). Usually after completion of the incision the iris remains in its normal position, especially if the patient is quiet, but should the pupil be distorted or the iris prolapsed, reposition is done according to the prescribed rules. It may happen that, when the dressing is changed on the following day, the iris is found misplaced

or prolapsed, in which case it is best to perform an excision of the prolapse.

Accidents may occur during the execution of an anterior sclerotomy, the most important of which are the following:

1. **Intralamellar incision,** mention of which has already been made. If the faulty incision is discovered before the anterior chamber is perforated, it is best to withdraw the knife and to make a new

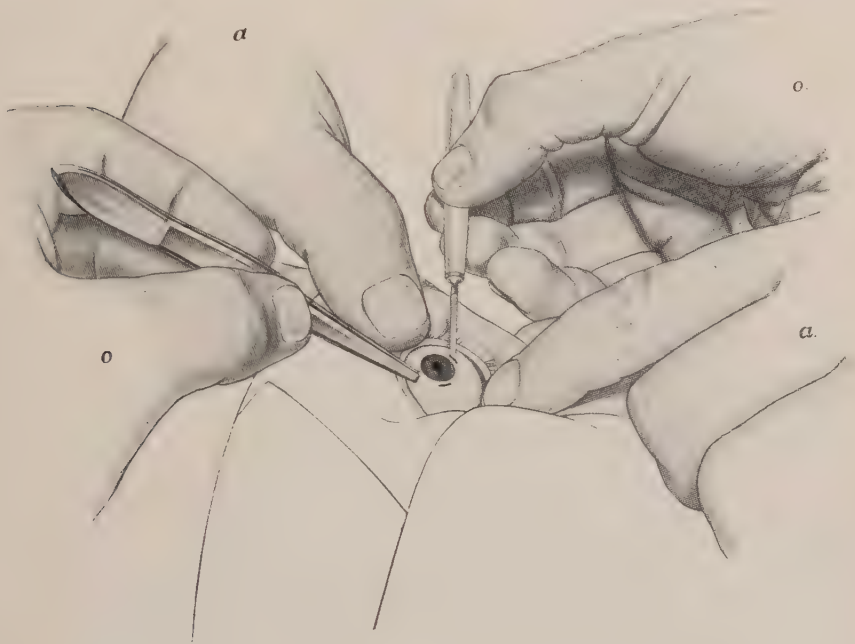

FIG. 103.—Termination of the incision. In order to cut through the inner lamellæ of the sclera in the neighborhood of the scleral bridge, which is permitted to remain, the knife is turned by an elevation of its handle in such a manner that its point produces the desired incision into the angle of the chamber.

Compare the position of the operator's hand holding the knife while performing the first act of the operation (Fig. 101) and while withdrawing it (Fig. 103).

puncture. If, however, the aqueous humor has already escaped, the operation must be interrupted, as it is impossible to continue it without injuring the iris. The traumatic opacity of the cornea consecutive to an intralamellar incision is of no real significance, as it eventually clears up completely.

2. **The incision may not lie far enough in the periphery.** As we can expect favorable results from the operation only when the cut

passes through the angle of the chamber, it is a serious mistake to place it at the limbus or in the cornea itself, except when the root of the iris is adherent to the posterior surface of the cornea, thus displacing the angle of the chamber further forward and making it impossible for the operator to begin the incision to the outer side of the limbus, as the knife would then be carried in back of the iris.

3. An accident occasionally noted in this operation in connection with the misplacement of the recess of the anterior chamber is **iridodialysis,** the knife carried to the periphery dividing the iris-root adherent to the cornea. A severe hemorrhage may follow this injury.

The results of anterior sclerotomy are in the greater number of cases not only temporarily good, but also permanently lasting, if the operation is not used as the primary one in glaucoma, but is reserved for cases, in which after a formal iridectomy there is a renewed increase of pressure. In such cases it is our custom not to perform a second iridectomy at once, which, as it would have to be made below, is always followed by a severe disturbance in the visual power, but to place our reliance on an anterior sclerotomy. When necessary this operation may be repeated several times on the same eye, and it is optional whether the incision should be made above, below or at any other favorable point. In the eyes with a coloboma upward we prefer to make the sclerotomy below, to have the knife separated from the anterior capsule of the lens by the iris, to insure against a possible injury of the capsule.

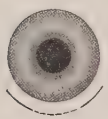

FIG. 104.—In this diagram the solid line represents the perforating cut, the dotted line that part of the incision, in the range of which only the inner lamellæ of the sclera are cut through.

In this, as in every glaucoma-operation, the eye must be energetically treated with eserin before the operation, in order to bring about as marked a contraction of the pupil as possible.

Anterior sclerotomy is recommended for simple glaucoma, as well as hemorrhagic glaucoma and hydrophthalmos. In hemorrhagic glaucoma it should be used as a preliminary operation, to lower the pressure, in order that an iridectomy may be performed later under less dangerous conditions.

POSTERIOR SCLEROTOMY.

This operation consists in the pucture of the vitreous space through the sclera with a Graefe cataract-knife. In order to avoid injuring the

more important parts of the eye, the following rules must be observed: The perforation of the sclera is made posterior to the ciliary body; that is, at least 6 7 mm. from the limbus in the human eye. As the nose interferes with such a peripheral incision on the inner side of the eyeball, the operation is usually performed to the outer side, or best

FIG. 105.—Posterior sclerotomy. The eye, which is directed well upward and inward, is fixed with forceps at the limbus and Graefe's knife is introduced at the outer and lower portion in a meridional direction, the cutting edge looking backward, the point toward the center of the eyeball. The assistant pushes the lower lid far downward.

at the outer and lower portion between the external and inferior rectus muscles, while the patient looks inward and upward. The eye is fixed with forceps to prevent any unexpected movement. In posterior sclerotomy the cutting edge of the instrument is directed backward; that is, away from the ciliary body so as not to bring this organ into danger. The incision is made in a meridional direction, corresponding to that of the fibers of the sclera and the blood-vessels in the chorioid.

An equatorial incision, that is, one parallel to the limbus, would divide a series of blood-vessels in the choroid. For the same reason the cut must not be placed in the horizontal meridian, because the posterior long ciliary artery runs in this direction. Injury to this vessel would destroy the eye through a severe hemorrhage into the vitreous.

During the puncture the point of the knife is directed toward the center of the eyeball, in order not to pierce the posterior capsule of the lens, which could readily occur if the blade were passed obliquely forward (Fig. 105). Moreover, the puncture must have a definite length—as long as the breadth of the knife. In order to lower the tension of the eye by the escape of a small amount of vitreous humor, the knife must be turned, while in the scleral wound, from a meridional direction to an equatorial one (Fig. 106), so that the wound is caused to gape. After the knife has been returned to its original position, it is withdrawn from the eye.

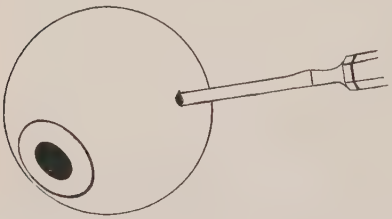

FIG. 106.—In this diagram, the knife, which is now in the eyeball, is turned to the equatorial direction, so that the wound gapes allowing the vitreous to exude.

Indications.—Posterior sclerotomy is of small value as an operation for glaucoma, as the diminution of pressure induced by it usually soon disappears, sometimes after a few hours, and the scar which is later to be met with at the site of the incision is so dense that a filtration of the ocular fluids outward cannot take place. Hence, *posterior sclerotomy is used in glaucoma only as a preliminary operation* in cases in which iridectomy is technically impossible because of the complete obliteration of the anterior chamber in the presence of enormous increase in pressure. In most cases an iridectomy may be proceeded with immediately after the posterior sclerotomy, as the escape of the vitreous produces a softening of the eyeball and simultaneously the anterior chamber commences to reappear. Posterior sclerotomy is further employed in puncturing the sub-retinal space in **detachment of the retina.** In such cases the operation must often be repeated, and, according to Deutschmann, may be associated with perforation of the retina itself. Good results are unfortunately not to be expected. The principal value of posterior sclerotomy lies in the possibility of employing it as an accessory operation in the **removal of foreign bodies** from the vitreous chamber, as will be found described elsewhere.

CYCLODIALYSIS (HEINE).

The Operation.—Cyclodialysis, invented by Heine, is executed in the following manner: While the patient looks upward, an incision

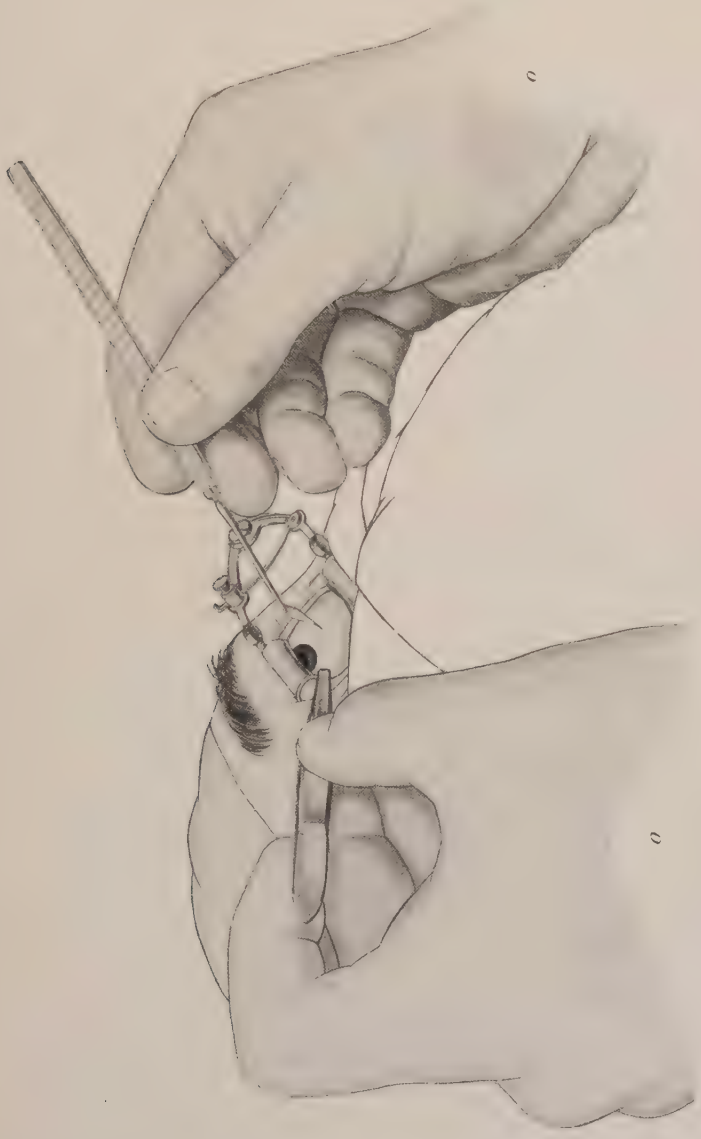

FIG. 107.—Cyclodialysis on the left eye. The eyelids in this operation are held apart by a spring-speculum. After the conjunctiva has been incised and the sclera exposed to view, a short incision is made with the lancet (keratome) parallel to the limbus and at a distance of about 5 mm. to the outer and lower side of it. The lancet is made to cut with its side and not with its point.

is made with the scissors into the conjunctiva at its outer and lower part, at a distance of about 5 mm. from the limbus, and the sclera

exposed by undermining. An assistant holds the wound open with two double tenacula, and a cut 2 mm. long is made with the

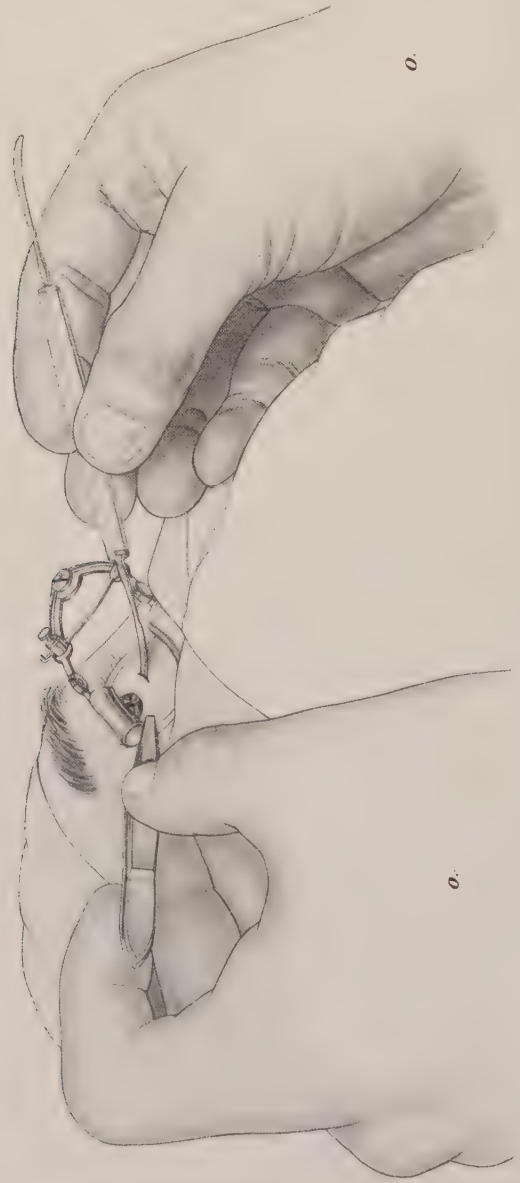

Fig. 108.—The spatula, held parallel with the surface of the sclera, is now inserted through the wound in the sclera in front, between the sclera and the ciliary body, and appears in the angle of the chamber.

lancet vertically through the sclera at a distance of 5 mm. from the limbus and parallel to it (Fig. 107), the eye being fixed with forceps.

As the ciliary body, which lies immediately beneath, must not be injured, we must proceed very cautiously with the cutting, and slowly divide the tissues layer by layer, until the black of the uvea appears in the wound. The incision is not made with the point of the knife, but with one of its lateral edges, so that the same depth is kept in the entire length of the wound.

Next a spatula, such as is used in reposition of the iris, under continuous fixation of the eye is carefully carried forward through the wound between the sclera and the ciliary body, with its plane parallel to both (Fig. 108). If all the fibers of the sclera have been divided, this can be done without any resistance. Soon the point of the spatula

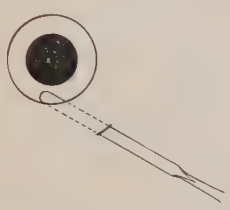

Fig. 109.

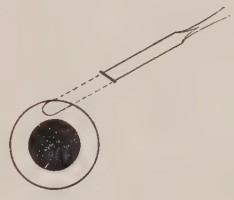

Fig. 110.

Figs. 109 and 110 show the position of the spatula during the performance of the lateral movement intended to detach the ciliary body.

appears below in the angle of the chamber. Now the spatula is pushed forward with lateral movements to the right and to the left (Figs. 109 and 110) and in this manner the ciliary body is detached from the sclera. The aqueous humor does not escape during this procedure, unless one edge of the spatula is turned forward slightly, causing the wound to gape. If the ciliary body is not hurt during the incision, no bleeding occurs into the anterior chamber.

At the beginning of the operation we must be careful not to injure the anterior ciliary veins, which are often dilated in glaucomatous eyes, as such a hemorrhage would not only make the further progress of the operation difficult, but also during the introduction of the spatula cause blood to be sucked into the anterior chamber. Bleeding from the small scleral vessels is best prevented by repeated dropping of adrenalin into the wound during the incision. One may even be compelled to stop severe hemorrhage from a ciliary vein, injured at its point of exit from the sclera, by application of the thermocautery. If the cut is carried too deep, the vitreous may be pushed into the wound

after division of the uvea. The spatula must be introduced carefully and pushed forward close to the posterior surface of the sclera, in order not to get behind the iris. By the entrance of the spatula into the anterior chamber the **ligamentum pectinatum is divided,** the angle of the chamber opened, and the ciliary body, together with the iris springing from it, is detached from the sclera.

An iridodialysis is no more to be feared than an injury to the canal of Schlemm, as the iris arises from the anterior surface of the ciliary body, and the latter is sufficiently protected through a projection of the sclera. Occasionally, the detachment of the ciliary body from the sclera may be plainly distinguished by the recess of the chamber becoming black just as in iridodialysis. After withdrawal of the spatula the ciliary body resumes its original position and the angles of the chambers show no further visible alteration. If, during the operation, a hemorrhage into the anterior chamber occurs, a pressure-dressing must at once be applied. This not only prevents a further accumulation of blood, but also causes a disappearance of part of the blood already present in the eye.

One of the most frequent complications is the **detachment of Descemet's membrane** from the cornea. If the spatula is not sharp enough to sever the fibres of the ligamentum pectinatum, it may glide in front of them on the anterior side of Descemet's membrane, thus getting caught between the latter and the parenchyma of the cornea. This faculty position of the instrument is recognized by a marked resistance. By slightly withdrawing, the spatula must be freed before the undermining is performed, otherwise the membrane becomes detached, thus leading to an opacity of the corneal parenchyma, which, however, disappears within a few weeks. Generally the spatula finds its right way even in those eyes in which the root of the iris is attached to the posterior surface of the cornea (peripheral anterior synechia), and an iridodialysis is an exceptional occurrence.

After withdrawing the spatula from the wound the **conjunctiva is sutured** and the eye bandaged.

The operation is undoubtedly much less radical and associated with much less danger for the eye than an iridectomy. To test its influence, I purposely did not permit the aqueous humor to escape from the eye in most of my cases, so that immediately after the operation the eye was as hard as before. In this manner, therefore, I could observe the effects of the operation with the factor of puncture omitted from

consideration. I do not mean, however, that one should not let out the aqueous humor, as it may be irremissible to reduce the tension at once. Neither do I use miotics after the operation, although we think their employment is a great advantage, because the consequent contraction of the pupil aids in pulling the freed root of the iris away from the angle of the anterior chamber.

The proper **results of cyclodialysis** develop *gradually* and attain their highest degree only *one to three days later*. According to the condition of the eye after the operation, three kinds of cases may be distinguished: Those in which (1) the tension is reduced permanently; (2) the diminution of the pressure is only temporary; (3) the operation had no influence at all. In the first class of cases (about 30 per cent.) the tension sinks gradually during the first three days after the operation, and the eye may even become softer than normal. The previously hazy cornea becomes lustrous, the anterior chamber somewhat deeper, though it remains shallower than normal, the pupil a little less dilated than before. In this condition the eye may remain permanently. In about 40 per cent. the diminution of the tension is only temporary and the increase of pressure returns within a few weeks; and in about 30 per cent. the operation had no effect at all on the glaucoma. This is the result especially in *glaucoma absolutum*.

Cyclodialysis is indicated in, 1. Cases of **primary glaucoma,** in which the iridectomy is not only difficult but *dangerous*, either because of the increase in pressure being very high, or the intra-ocular changes so far advanced, that a regular iridectomy is practically impossible (no anterior chamber, atrophic iris, maximal dilatation of the pupil). The performance of the cyclodialysis is *independent of the existence of the anterior chamber*, and complications mentioned in iridectomy may be disregarded.

Even though the reduction of pressure may be only a temporary one, the operation has to be considered as a valuable **preliminary to iridectomy.** If the tension is once diminished by the cyclodialysis, an iridectomy can be accomplished without any of the dangers already described.

2. In cases of glaucoma in patients who have lost the other eye by *glaucoma malignum* or a severe hemorrhage after an iridectomy, also in old, infirm, coughing or restless people, because after this operation such patients do not need to be kept in bed.

3. The operation renders remarkable services in certain cases of secondary glaucoma caused: (*a*) By anterior synechia, in which in spite of iridectomy the tension increases again. (*b*) By luxation of the lens in the vitreous chamber. Loss of vitreous, unavoidable in performing an iridectomy and rendering the same dangerous and its result uncertain, does not complicate the cyclodialysis. (*c*) After cataract-extraction, provided that the edges of the coloboma are in their proper position. If there is adhesion of one or both sides of the coloboma to the operation-scar, the excision of the attached iris is, of course, indicated (page 190).

In brief, cyclodialysis, though able to diminish the intra-ocular pressure, cannot be called preferable or even equal to the iridectomy. It should not be used indiscriminately in place of iridectomy, but should be considered as a valuable aid when iridectomy fails or is contra-indicated.

The suggestion of this operation by Heine had its origin in the articles by Fuchs giving detailed descriptions of the chorioidal detachment following iridectomy for glaucoma and extraction of cataract, pointing out the *co-existent diminution of pressure*, and presuming that the chorioidal detachment was brought about by the aqueous humor oozing backward through tears in the *ligamentum pectinatum* produced by the operation. Heine tried, by establishing through an artificial cleft in the ligament a communication between the anterior chamber and the suprachorioidal space, to give rise to a detachment of the chorioid and thereby to a reduction of the intra-ocular pressure. In conceiving the method of the cyclodialysis he took for granted, first, that the tear would not heal again spontaneously, and, second, that the suprachorioidal space represented either a natural passage for the intra-ocular circulation respectively for the carrying off of the liquids from the interior of the eye, or that it was created such a one by the operation. But the expected detachment of the chorioid failed to appear, even when the eyes had been perfectly soft. The fact that in successful cases the tension remains below normal for months proves that the result is independent of a supposed detachment of the chorioid, which, as a rule, passes away within a few days or, if extensive, within a few weeks, and with it the lowering of the tension. The theory, therefore, on which the operation had been based, seems to be incorrect. But this should not bias our actual judgment. It is likely that the occasional success is accomplished by the undermining of the angle

of the anterior chamber. Cyclodialysis should be regarded as an operation to free this angle, just as many other methods that have been recommended for glaucoma, to which iridectomy also probably belongs.

OPERATIONS FOR SECONDARY GLAUCOMA.

The **indications** for operation in secondary glaucoma are dependent upon whether the phenomena are only *temporary* or whether the increase of pressure will remain *permanent*.

Paracentesis of the cornea is indicated in transient increase of pressure; as, for example, in traumatic cataract with rapid swelling of the lens; and in acute iritis, in which the increase in pressure is associated with the anterior chamber deeper than in the normal eye. However, the operation should not be done until after the usual local applications of ice-compresses and atropin have failed, especially in cases of iritis.

The incision is made with the lancet at the limbus below and not more than 3 mm. long. The cocainized eye is fixed laterally. The site of fixation is not so important as an iridectomy is not contemplated, and the incision need not be made exactly in the vertical meridian. The lancet, held in the right hand, is applied almost vertically against the limbus, and penetrates the cornea. The length of the cut, however, must not exceed 3 mm. As soon as the point appears in the anterior chamber, its direction must be changed to that of the plane of the iris, as in operations previously described. All backward movements of the lancet should be avoided, in order to prevent a disastrous escape of the aqueous humor.

When the lancet is now withdrawn, the wound-edges come together so that the aqueous cannot flow off. The operator may permit it to run out as slowly as he desires and in any quantity he pleases, by slightly depressing the scleral wound-margin with the spatula, thus making the wound a little gaping. Sudden escape of the aqueous humor is not only painful, but may cause prolapse of the iris and hemorrhage from the iris, and even in the retina as a result of the sudden diminution of pressure. A lancet with stop-shoulders has been devised which will prevent an over-penetration into the eye, but such instruments are superfluous for the operator of experience. No force must ever be employed when introducing the lancet. If the point is bad, it is preferable to use another instrument. A faultless

knife-point penetrates the cornea without any appreciable resistance. If the pressure is greatly increased, it is our custom not to permit all the aqueous humor to escape, but only just as much as to reduce the pressure to normal or a trifle below. Thus we are most likely to preclude disastrous intra-ocular hemorrhages. If the iris is floated out during the sudden escape of the aqueous humor, it should be at once accurately replaced with a spatula. Only in exceptional cases, when the protrusion of the iris is several times repeated, is excision of a small piece indicated. This unpleasant accident occurs when the incision has been made too long.

Puncture of the cornea may be repeated as often as needed. If, for example, in acute iritis the tension increases the next day, the scleral lip of the wound after cocainizing may be slightly depressed with the spatula and the aqueous humor allowed to again escape. The healing of the wound does not advance so quickly for several days as to hinder easy re-opening by passing the spatula carefully between the edges.

If the corneal puncture is made because of increase in pressure, the result of **swelling of the lens,** it is better to make the cut somewhat longer (5 mm.), so as to permit not only the aqueous humor to escape, but also extract some of the lens-mass itself by massage, as described elsewhere. In such a case the operation more nearly resembles a linear extraction.

Puncture of the cornea may also be employed in **progressive corneal ulcers,** and is then frequently combined with cauterization of the ulcer. The puncture may be advantageous in those cases in which a rupture is imminent. The obliteration of the anterior chamber by the puncture overcomes all the disadvantages of a sudden rupture of the ulcer, such as prolapse of the iris, etc. In chronic inflammation of the cornea (*keratitis profunda*) puncture occasionally exerts a favorable influence on the disease-process.

Secondary glaucoma, in which the increase of pressure is certainly not of transient nature, requires a **typical iridectomy,** as described in the chapter on primary glaucoma. This is true, therefore, in increase of pressure due to adhesion of the iris to the cornea or to change of position of the lens, and other conditions, as previously mentioned.

The performance of the iridectomy in secondary glaucoma may be difficult because of the accompanying pathological changes in the eye. For instance, the **iris** may be so atrophic from the chronic

inflammation that it cannot be pulled forward with the forceps, as it tears at the slightest touch, and we must be satisfied with tearing out single pieces with the forceps instead of excising one section. Again, the iris may have grown fast to the lens-capsule, and we may succeed in drawing it forward and in excising a portion, but the pigment-layer remains adherent to the lens-capsule, rendering valueless the optical effect of the operation.

In **luxation of the lens** or **ectasia of the sclera** it is **prolapse of the vitreous** which produces severe complications during the operation. We should never operate in a case of luxation or subluxation of the lens (except luxation in the anterior chamber) unless forced to by an increase of pressure. Experience has shown that some eyes tolerate a displacement of the lens without a corresponding increase of pressure, at least for some time. Operative procedures in these cases are always so dangerous that they should be postponed until the last resort. As the zonula is torn, the vitreous presents in the wound as soon as the incision is made. If the iris is floated forward, it may be easily grasped and excised. If, however, the vitreous pushes the iris backward, all attempts to bring it forward with the forceps would terminate in failures and should, therefore, be abandoned. Occasionally we may be able to catch the iris with a blunt hook and to draw it forward. Should that also fail, one has to desist from excising a piece of the iris. If afterward the operative wound becomes ectatic and the eye constantly painful because of the increased pressure, and vision is ultimately lost, nothing remains to be done except to enucleate the eye.

If the **lens is displaced into the anterior chamber** an operation for its removal must be immediately undertaken, as experience has shown that in such cases increase in intra-ocular tension quickly follows. In order to prevent a slipping of the lens backward into the vitreous chamber, the pupil is first contracted with eserin. Then the anterior chamber is opened by an incision with Graefe's knife at the lower limbus and the lens brought forward with the loop. As the vitreous and anterior chamber openly communicate, the appearance of the vitreous in the wound is the rule in spite of precautions.

If a **cyst of the iris** has led to increase of pressure we must not be satisfied with an iridectomy alone, but endeavor to extirpate the entire cyst by suitable incision.

The operation for increase of pressure in **seclusion of the pupil,** when the iris has been pushed forward in the form of a hump, deserves

special mention. A formal iridectomy is hardly possible as the root of the iris is often applied extensively against the posterior wall of the cornea. The operation adapted for such cases is **transfixion**. This is done with a Graefe knife, which is pushed into the anterior chamber through the cornea 1 mm. to the inner side of the temporal border of the cornea and a counter-puncture made at a symmetrical point. The knife is then pulled out. The points of entrance and exit lie in the horizontal meridian of the cornea, and the blade of the knife, held

FIG. 111.

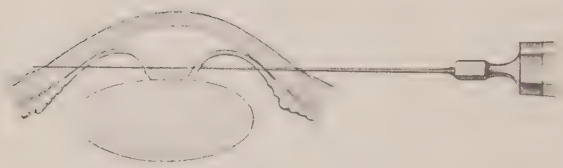

FIG. 112.

FIGS. 111 and 112. Transfixion in seclusion of the pupil.

parallel to the base of the cornea, penetrates through the projecting iris and produces in it several openings (Figs. 111 and 112), through which a new communication is established between the anterior and posterior chambers. In most cases the iris assumes its normal position almost at once and the intra-ocular pressure becomes normal. If no new inflammation of the iris follows, a permanent result may be expected. If, however, there is a new outbreak of iritis, which would cause a closure of the openings through a formation of an exudate, it is better to proceed to establish a normally deep chamber and then to perform a regular iridectomy, in order to prevent a recurrence of the increase in pressure.

CHAPTER XVII

PROLAPSE OF THE IRIS. CONJUNCTIVOPLASTY.

Every Prolapse of the Iris should be Excised.—Attempts at reposition of a prolapsed iris should be avoided, not only on account of the danger of intraocular infection, but also because of the uselessness of such a procedure. The replaced iris will again prolapse. It is, therefore, best to excise not only an iris that has protruded through the opening of a perforated ulcer or through a wound due to injury, but also a prolapsed iris following an extraction without iridectomy.

The Operation.—Not only should that portion protruding from the opening be cut off, but the iris should be completely freed from its connection with the wound, in order to avoid the formation of an anterior synechia, with its consequent sequelæ. As the prolapsed iris rapidly becomes covered with fibrinous exudation, making its borders indefinable, this exudate must first be pulled off with a forceps, after which the black point or swelling of the prolapse makes its appearance. By means of a conical sound the prolapse is then freed from the edges of the wound in all directions. In doing this it is necessary to avoid wounding the capsule of the lens, which, by obliteration of the anterior chamber, is brought to lie close to the posterior surface of the cornea. The sound is carefully pushed around the whole periphery of the opening between the prolapse and the posterior surface of the cornea, so that the iris is loosened on all sides. During this attempt the aqueous humor is continually escaping. The prolapsed iris is then seized with the iris-forceps close to the opening, drawn out a little, and cut off with the de Wecker's scissors close to the edge of the wound. As the iris usually retains its power of retraction, immediately after the excision, it withdraws itself into the anterior chamber, and produces a well-situated coloboma in place of the previous prolapse.

If the edges of the coloboma do not lie in a proper position, and the size of the opening permits, it is advisable to introduce a spatula and replace the iris. As this may be impossible with a small opening, care should be taken to draw out and excise enough of the iris to allow it to spontaneously withdraw to a sufficient extent. If, however, the latter does not occur, an attempt must be made to introduce a blunt tenaculum

into the anterior chamber, and, withdrawing it out of the wound between the iris and the posterior corneal wall, pull out the iris caught in the hook, so that a proper excision can be done. After the operation is completed a drop of atropin is instilled in the eye to retract the iris as far as possible and avoid its adhesion to the edges of the wound. The fact that the prolapse has occurred through perforation of an ulcer is not a contraindication to its immediate excision, notwithstanding the claim that there is great possibility of an infection of the interior of the eye through replacement of the borders of the coloboma. If the tendency to infection should exist, the prolapse would afford the best channel by which the microörganisms could gain entrance to the eye.

Excision of a prolapse of the iris may occasionally be difficult and it is necessary to cocainize thoroughly the conjunctival sac by instillation of a 3 per cent. solution. As the eyes are usually much irritated and injected, adrenalin should be used simultaneously, as the cocain develops its greatest effect after contraction of the blood-vessels. Notwithstanding thorough cocainization, the iris often remains extremely sensitive, and in spite of fixation of the eyeball with forceps, especially at that moment when the iris is drawn out and excised, an abrupt movement of the patient may give rise to severe injury of the iris (**iridodialysis**). In children the operation should always be done under general anesthesia. This should also be the rule in restless and timorous adults.

A second danger is the possibility of a **wound of the capsule of the lens.** This can be readily avoided if the operator takes sufficient precautions in introducing the blunt tenaculum for the purpose of replacing the iris. However, this accident may be caused by restlessness on the part of the patient during the undermining of the prolapse with the pointed conical sound. If cocain is dropped directly on the prolapsed iris after it is uncovered, its sensitiveness is greatly diminished.

The wound in the cornea which remains after excision of the prolapse, usually closes rapidly; frequently the anterior chamber is reestablished on the day after the operation. The smaller the opening, the more readily and surely does the wound close. The conditions for healing are less favorable in large perforations. It is our established rule **not to excise a prolapse of the iris if the opening amounts to one-fourth the diameter of the cornea.** Naturally, this can not be readily determined in advance. A large prolapse sometimes

comes out through a small opening and, with mushroom-like swelling, overlaps the borders of the corneal wound. If the patient has been seen before the prolapse occurred, the operator will not be thus deceived, but it may happen that the real conditions are revealed only at the time of operation upon attempting to undermine the prolapse. When, for example, one-fourth or more of the cornea has been lost by ulceration, the excision of the iris brings the lens-capsule to lie in the wound throughout its extent. As the scar-formation is not as rapid in the cornea as it is in other tissues, the wound may remain open for some time, and during this period the eye is constantly exposed to the danger of infection. If the exposed lens-capsule cannot withstand the intra-ocular pressure, it finally protrudes and ruptures, the lens-substance first appears in the opening and later the hyaloid membrane bursts, allowing the vitreous humor to prolapse. These sequelæ are to be feared only in large prolapses, such as occur in destruction of the cornea by acute blennorrhea or serpiginous ulcer. But even with the medium-sized openings, the operator has to be satisfied if a flat cicatrization results with fusion of the lens-capsule and partial or total clouding of the lens. Frequently these cases end with a slowly developing atrophy of the eyeball. Therefore, it is best not to excise the prolapse, which let alone will form the natural means of closing the large wound. The endeavor should be rather to produce merely a flat cicatrix. Therefore, the intra-ocular pressure should be carefully controlled, and if it rises, an immediate iridectomy done.

In **extensive synechia** an iridectomy should be performed before the patient leaves the hospital, in order to avoid the danger of increase in pressure and development of a staphyloma. The continuous application of a pressure-bandage is advisable to produce a flat cicatrix. A typical picture is seen in those patients who have suffered from a well advanced serpiginous ulcer. An extensive synechia of the iris has been produced, either spontaneously or after Saemisch's incision, with a peripheral part of the cornea still transparent. At first the tension is reduced, but finally becomes normal. At the seat of the prolapse there is formed a flat scar. Suddenly the pressure increases, usually with violent pains, and immediately the still soft cicatrix, which is often the seat of hemorrhages, protrudes in the form of a hump. Under such circumstances the performance of iridectomy is difficult, as the anterior chamber is usually obliterated, the iris atrophic, and the eye painful. This almost invariable result can be avoided if a

broad iridectomy is executed in the unaffected portion of the cornea as soon as an anterior chamber has been established during the course of cicatrization of the prolapse and before tension rises.

Conjunctivoplasty is a significant advance in the treatment of large prolapses of the iris which is advocated especially by Kuhnt. By this means it is possible to excise even a large prolapse, to protect the eye from extensive synechia and at the same time close the defect by solid tissue.

The operation is as follows: After excision of the prolapsed iris, a cleaned ulcer with the perforation lies exposed. Either the edges of the defect are flat and offer a larger surface for adhesion to the conjunctival flap, in which case the edges should be scraped with a sharp curette, to remove the epithelium that has grown over them, or they are perpendicular, in which case the chances for fusion with the flap are less favorable. A flap is now made from the bulbar conjunctiva by first detaching with the scissors the conjunctiva at the limbus corresponding to the ulcer, making a second cut parallel to the first at a distance almost twice as great as the width of the ulcer, and uniting the two by a curved incision (Fig. 113). The flap formed in this manner is undermined, and its base removed far enough back to render it freely movable. If the ulcer is at the edge of the cornea, the flap may arise from the bordering limbus; but if the loss of substance is central, it may be covered either by a flap brought horizontally over the cornea or by one drawn vertically over it. In the former case the detachment of the conjunctiva must be performed above or below, and the base of the flap must lie externally or internally. The latter method is, therefore, to be preferred on account of the abundance of conjunctiva in the superior fold, which readily permits the formation of a flap, while internally and externally there is little conjunctiva to spare. The only objection is the possible danger of limiting the movements of the eyeball by shortening the conjunctival fold to too great an extent.

FIG. 113. — Conjunctivoplasty. Diagram showing appearances after excision of the prolapsed part of the iris. The ulcer in the lower half of the cornea is free from the iris, which shows the ordinary coloboma. To cover this defect a flap has been cut out of the bulbar conjunctiva.

After the flap has been rotated to the correct position, so that it well covers the loss of substance, its apex is fastened by a few fine silk-sutures to the bulbar conjunctiva on the side opposite to that on which the base

of the flap is attached (Fig. 114). As the conjunctiva often shows a tendency to curl, one or more sutures may be introduced through the lateral edges of the flap, in order to keep it well stretched. Naturally, too much dependence cannot be placed upon these sutures, as they frequently cut through as early as the following day. Still, even this short period usually suffices to maintain the flap in its correct position. The wound in the bulbar conjunctiva left by excision of the flap may be permitted to heal by itself, especially if there is difficulty in covering it by drawing upon the surrounding membrane; or an attempt may be made to at least partly draw the conjunctiva over the defect with the aid of incisions to relieve tension.

Fig. 114.—Diagram showing the conjunctival flap turned over the ulcer, and attached to the bulbar conjunctiva in such manner that the ulcer is completely covered.

After the operation both eyes are bandaged to insure a proper position of the flap by excluding the possibility of ocular movements. Before applying the dressings, the operator should assure himself that the flap does not shift its position during the upward rotation that accompanies closure of the eyelids, and, if necessary, introduce an additional suture to prevent this displacement. The bandage should be changed on the following day, as we have to deal frequently with excessive conjunctival and lachrymal secretion. Both eyes are kept closed for at least three days. At first the flap appears quite swollen, and some time may elapse before it again assumes the condition of normal conjunctiva. It is generally not necessary to remove the stitches, as they drop out of themselves in a few days. If the loss of substance has occurred in the middle of the cornea, the separation of the flap from its base can be undertaken when the eye has become completely free from congestion and the process of healing is at an end. The results of this operation are in many cases remarkable, but occasionally, in spite of closure of the ulceration, an atrophy of the eyeball finally sets in. Of course the method cannot be blamed for these bad results, as they are caused by severity of the primary changes.

Conjunctivoplasty is not limited to perforating ulcers, but is valuable in losses of substance from other causes, especially to gaping wounds following injury.

In **transplantation of the cornea,** a conjunctival flap properly applied over the cornea will retain the transplanted piece in its position during the first few days. When the piece has become attached with

sufficient firmness, the conjunctival flap may be returned to its original position or may be excised.

De Wecker's method of transplantation is of great value in severe injuries. It consists in undermining the conjunctiva on all sides from the limbus to the insertions of the recti muscles, after which this movable conjunctiva is drawn completely over the cornea and closed in purse-string fashion by several sutures. The raw surface of the conjunctiva closes the defect and fuses with the edges of the wound. After completion of the cicatricial process, the conjunctiva may again be detached, after which it returns to its normal position in all directions, with the exception of the point of fusion. A total detachment of the conjunctiva at the limbus is not always necessary; a partial detachment may suffice to draw the conjunctiva over the cornea and attach it to the opposite limbus.

The cases thus far discussed refer to prolapse of the iris through a wound of the cornea or at the limbus. There remains to be considered the method of procedure in **wounds of the sclera with prolapse of portions of the ciliary body or chorioid.** If the injury is not too severe, so that there is hope of preserving the eye, the same rule is to be observed as in prolapse of the iris. The prolapsed portion is excised, the operator being satisfied with removal of that part which lies exposed in the wound. For reasons that can readily be understood, we avoid drawing upon the prolapse with the forceps. The wound is closed by sewing the conjunctiva over it. If it is desired to introduce **scleral sutures,** they must include only the superficial layers of the sclera, so that the needle does not produce a perforation and thus cause a fresh injury of the deeper parts. Scleral sutures are usually not employed, as the pressure necessary to pass the needle through the sclera causes further protrusion of the vitreous which lies in the wound. Scleral sutures are advisable only if the wound gapes; in which case they will prevent the formation of a wide cicatrix that would likely upon contraction lead to detachment of the retina. Absolute rest of the patient and bandaging of both eyes during the first few days are necessary requisites to promote healing of the wound. If a large part of the ciliary body or of the chorioid has prolapsed, the best course is to enucleate the eyeball at once. By this means the patient is relieved of a long convalescence, which ends with an atrophic bulb that is subject to repeated attacks of pain and is a source of danger, causing sympathetic ophthalmia.

A natural question is, **how long after the occurrence of the prolapse may excision be undertaken?** The possibility of loosening the prolapsed iris with the conical sound presupposes a loose connection between the iris and the edges of the wound. If cicatrization has advanced too far the undermining with the sound can no longer be carried out. No definite time can be stated. Even after two or three weeks a slight adhesion may be found between the prolapsed iris and the edges of the wound, so that their separation, though difficult, is still possible. When the cicatrization has already led to a firm union, so that an ectatic black scar is seen in place of the prolapse, the manner of the operative interference again depends materially upon the size of the prolapse. The simplest method is to avoid freeing the iris from the corneal scar and to perform a broad iridectomy behind the normal portion of the cornea. In this way the pressure is diminished, and by simultaneously applying a pressure-bandage, an attempt is made to produce a flat cicatrix. Although this simple procedure often leads to the desired result, it fails in many cases, for the ectasis of the cicatrix sometimes does not disappear after iridectomy, and the eye may be destroyed by a renewed increase in pressure.

For these, as well as for all other cases of **anterior synechia** (especially when the cicatrix is not solid, but dimly transparent or somewhat ectatic), modern ophthalmic surgery has proposed separation of the iris from the cornea, and has devised various methods for its accomplishment.

When the scar is small, and the prolapse the size of a fly's head or slightly larger, it is best to cut off the protruding cicatrix with a lancet applied flat against the cornea. The opening in the cornea is usually too small to permit the introduction of iris-forceps for the withdrawal and excision of the iris. The latter is better accomplished by means of a blunt hook. After its excision, either the iris is drawn back spontaneously into its proper position, or it may be pushed back with the blunt tenaculum, as the introduction of a spatula through the small opening is impossible. The small wound cicatrizes in a short time, and the anterior chamber is usually established on the following day.

When the ectatic cicatrix is large, it is removed with the lancet as before, and the iris is more readily excised as it can be drawn out with the forceps. After this has been done, the defect is covered with a conjunctival flap as already described, the conjunctiva replacing the cicatrix.

CHAPTER XVIII.

CORNEAL TRANSPLANTATION. KERATOPLASTY.

Transplantation of the cornea consists in the removal of the cicatrix and its replacement by healthy corneal tissue. Fuchs was the first to recommend that the fistulous or ectatic cicatrix be excised with a corneal trephine, and that the defect be covered with a piece of cornea removed by a trephine from a freshly enucleated eye. Before covering the defect, the iris must be freed from its adhesions to the cornea. If the patients are not of a tranquil nature, it is necessary to perform the operation under general anesthesia, in order to avoid any increase of intra-ocular pressure by straining. The opening is made with a small trephine-crown. The cutting edge of the **trephine** should project very little, in order to avoid going too deep and injuring the capsule of the lens. The eye is held by forceps, and the trephine placed with slight pressure upon the cornea in the region of the cicatrix. The assistant then presses upon the button of the trephine. After a few rotations the instrument must be raised to determine the depth of the cut, and to observe finally if the instrument has perforated. As the scars are thin, perforation often occurs with unexpected rapidity. After the aqueous humor has escaped, if the circumscribed piece is not cut through in its entire circumference, rather than to re-apply the trephine, it is better to raise the flap with forceps at its cut end and carefully separate it at the periphery with a lancet. This is not difficult, as a rather deep furrow will have been made. On the posterior wall of the excised piece may be seen adhering the remnants of the pigmented epithelium, in accordance with the circumstance that the excised cicatrix is nothing more than the iris which has undergone cicatricial change.

Carefully avoiding the capsule of the lens, which lies exposed in the opening, the operator then proceeds with the forceps to draw the iris out a trifle on all sides, and to excise it with de Wecker's scissors. In doing this there is the danger of producing an iridodialysis, especially if the iris is short on one side. This is most likely to occur when the iris is roughly drawn out with the forceps. It is, therefore, better to

break up adhesions with a blunt tenaculum and thus free the iris, whereupon it will usually withdraw itself from the scar, or it may be pushed away with the spatula. The defect is then covered with a piece of cornea of the same size, removed with the same trephine from a freshly enucleated human eye. If the lens does not protrude it is sufficient to insert the piece without further fixation. It must not be forgotten to note which side corresponds with the outer surface i.e., which side is covered with epithelium. When the flap is placed in the proper position, the upper lid is drawn down carefully over the eye, and a bandage is applied to both eyes and is not removed for two days. It is possible that the flap may then be found in the conjunctival sac even though it may originally have lain in the correct position. But in the large majority of cases it remains fixed.

It may be seen, however, during the operation, that the flap shows no tendency to remain over the opening. This is especially the case if the lens or the hyaloid membrane protrudes, the latter in case the lens is wanting. Under these circumstances the flap must be fixed in position by a flap of conjunctiva, as already described, this conjunctiva serving the purpose of pressing the corneal flap upon its foundation during the first few days. The **conjunctival flap** must not be too small. A scanty flap cannot be sufficiently stretched, and, as it always has the tendency to slip off from the bulging cornea, it may even lead to a dislocation of the corneal flap. The conjunctival piece should be at least half again as wide as the corneal flap. Moreover, as the conjunctiva retracts when cut through, it is necessary in planning the conjunctival incision to circumscribe a strip fully twice as wide as the diameter of the corneal flap. The conjunctiva in these cases lies upon a surface completely covered with epithelium. There is, therefore, no adhesion between the two, and if the sutures have not spontaneously cut through, in the meantime, the conjunctival flap may be loosened in a few days and returned to its original position or excised. In every case of corneal transplantation both eyes should be kept bandaged for at least four days, and the patient should remain in bed. The transplanted flap becomes cloudy in the course of time, but it retains its firmness. By means of this operation, therefore, not only is the dangerously yielding and leaking scar removed and replaced by solid tissue, but also the iris has been freed from adhesions.

Partial keratoplasty consists in removing, by means of the trephine, a flap of cornea which does not include its whole thickness, sparing

Descemet's membrane at least. This method has been perfected especially by v. **Hippel.** It is suitable only for those cases in which the cicatricial clouding of the cornea that is to be replaced by a transparent piece does not include the whole thickness of the cornea. By means of the trephine (the crown of which should never exceed 4 mm. in diameter) a groove is cut to the required depth. The flap is then carefully cut out with the aid of forceps and a lancet applied flat, the result being that the transparent posterior layer of the cornea lies exposed in the defect. A corneal segment of the same size is then excised in its whole thickness from a suitable freshly-enucleated human eye. The defect is covered with this piece. The eyes are carefully closed and bandaged, the bandage being changed in three days. It can be entirely dispensed with in nine days. The adhesion of the transplanted piece usually occurs promptly, but the expectation that the flap will remain transparent is almost never realized. A complete cloudiness gradually develops.

Total Keratoplasty.—In this operation the scar is excised for the whole thickness of the cornea and is replaced by a transparent flap. In this case also the flap usually adheres well, but the cloudiness becomes complete in a short time. From an optical point of view, therefore, these operations are at present almost worthless. They are employed only to replace a fistulous or ectatic part of the cornea.

The trephine of v. Hippel contains a drum at its upper end, in which a clock-work arrangement is introduced. On the cover of the drum is placed a button; by pressing on this button with the finger, the crown of the trephine is set into rapid rotation. This crown can be varied in height, thus regulating at will the depth of the incision. The trephine contains a set of crowns of varying size..

It is evident that the operation for removal of an ectatic cicatrix with the trephine can only be applied to scars of small circumference; i. e., with a maximum diameter of 4 mm. If a large piece is trephined from the cornea, the transplanted flap usually will not hold, and the large opening will have to be covered later by a conjunctival flap. Therefore, for large ectatic scars there remains only the original simple method of producing a flattening of the scar by a broad iridectomy and subsequent pressure-bandage. Ectatic cicatrices should be removed by operative means, as they not only carry with them the danger of increased pressure, but also afford a portal of entry for infection of the eye. But increase in pressure may also occur in cases of anterior

synechia, in which the corneal scar is not only flat but also solid, especially if a considerable portion rather than a small tip of the iris is adherent to the scar.

Operations for Anterior Synechia.—It is difficult to give a general rule for operative interference in anterior synechia—a flat cicatrix being naturally implied. It has already been explained that an ectatic scar should be subjected to operation under all circumstances. But there occurs the question, should an operation be performed in every case of anterior synechia with flat solid cicatrix? By no means is this our belief. In deciding, the following are considered indications: (1) If the fusion is extensive, so that a large part of the pupillary border is adherent to the cicatrix. (2) If signs of increased pressure are present even though they occur but intermittently. (3) If the cicatrix, although originally flat, threatens to yield to the intra-ocular pressure (beginning protrusion). (4) If dislocation of the pupil, as a result of distortion of the iris, hides the pupillary opening completely behind the cicatrix. The latter may occur in a peripheral adhesion of the iris, when the pupil is so distorted that only the irregular refracting border of the cornea can be used for visual purposes. The same visual disturbance occurs when the pupil is directly covered by a central corneal cicatrix. In the fourth indication, the operation is demanded upon essentially optical grounds. While we were formerly well satisfied with iridectomy in all these cases, we now prefer a **temporary resection of the cicatrix** with the aid of the trephine—a method which was first recommended by **Sachs.** As the scar is solid, it does not require to be replaced by a piece removed from another cornea.

In order to avoid the danger of delayed healing of the excised flap of cornea, it is only separated in a little more than half its circumference by **placing the trephine obliquely upon the cornea.** In this way an assistant may lift the flap like a lid with a sharp tenaculum, while through the opening thus produced the operator enters the anterior chamber with the forceps or a tenaculum, draws the iris carefully out on all sides and excises it. The base of the flap is so placed that the iris can be most readily reached through the opening produced by lifting the flap. In most cases, therefore, this base will lie toward the center; that is, toward the pupil. After the iris is completely freed, the flap is returned to its original position, in which it is firmly held by the pressure of the upper lid when the eye is closed. A light compress and bandage may be used to support the lid. By the use of

atropin an attempt is made to retract the iris as far as possible from its former point of adhesion. The anterior chamber will be re-established on the next day, but it is advisable to keep the eye bandaged for at least one week. The corneal cicatrix, which was formerly somewhat thin and had already become slightly ectatic, is often observed to become flat and solid after this operation. After detachment of the iris from the cicatrix, the former withdraws, and the pupil returns to its position behind the center of the cornea. Therefore, by this means not only have the optical disturbances been remedied, but also the anterior synechia is removed. When the eye has become entirely free from inflammation, and healing is complete, a tattooing of the scar may be performed.

The only danger in trephining the cornea lies in an **injury to the lens.** Sometimes, unfortunately, this cannot be avoided, as, for instance, when the lens-capsule is adherent to the scar, and the capsule is cut when the corneal cicatrix is incised. But in these very cases the injury to the lens is not so important, as this structure is usually cloudy and, in young persons, frequently shrunken. The most dreaded sequel occurs after the escape of the lens-substance, when the delicate hyaloid membrane appears in the wound and ruptures, leading to prolapse of the vitreous humor and preventing continuance of the operation.

If the adhesion of the iris consists merely of a **fine filament** which, for example, unites the anterior surface of the iris with a solid corneal cicatrix, a division of this attachment is certainly not necessary. The same holds true of an adhesion between a small part of the pupillary border and the cornea, provided that the cicatrix itself is in good condition. Moreover, these are the cases in which the anterior synechia can be divided by the simpler means of the discission needle or the Graefe's knife.

In cases of anterior synechia produced by the **iris healing in an operation-cicatrix,** the mode of procedure cannot be governed by any general fixed rules. The point of view to be taken may perhaps be more readily comprehended from several examples: After an iridectomy for glaucoma, in which one or both sides of the excision have become adherent to the wound, no additional interference is called for if tension is normal and the operative cicatrix remains flat, presenting at most a dark coloration of the scar due to the adhesion of the iris. If fresh attacks of increased pressure arise, it would be a mistake to

proceed immediately to the performance of a second iridectomy, as the latter, being carried out inferiorly, would exert an unfavorable influence upon the visual function. Here, however, it is necessary to remove the adhesion of the iris.

The first method of operation consists in making with a lancet an incision corresponding to the adherent side of the coloboma; this incision should be as near the periphery as possible. Then the iris is drawn out with the iris-forceps and excised, whereupon it either spontaneously returns to its proper position or is replaced with a spatula.

The second method takes into consideration the possibility of an injury to the lens, and is, therefore, safer. An incision is made in the region of the iris-adhesion similar to that of an anterior sclerotomy. A Graefe knife is introduced on one side of the adhesion, and is brought out of the anterior chamber on the other side of the adhesion, and makes a scleral cut as near the periphery as possible, so that the iris is thereby severed from its adhesion. The incision need not be completed. Especially when a prolapse of the vitreous humor is to be feared, the flap should not be completely cut through, in order to avoid a gaping wound. If the iris does not retract after the incision, this method also permits the operator to draw the iris out with tenaculum or forceps to excise it to its proper position.

Operation for cystic scars after iridectomy for glaucoma is at present much under debate. Some authorities consider these cicatrices with their porous and filtrating properties favorable occurrences in glaucomatous eyes, and do not remove them unless forced to do so. Others maintain that it is better to free the iris and produce a flat cicatrix, thus protecting the eye from other dangers that may arise from cystic scars, especially the danger of spontaneous late infection.

CHAPTER XIX.

EXTRACTION OF FOREIGN BODIES FROM THE INTERIOR OF THE EYE.

The extraction of foreign bodies from the interior of the eye is usually a most delicate operation, particularly if attempted weeks or months after the original injury. There is no typical operative method that may guide the less skillful, and, as many of the most important structures of the eye are directly or indirectly affected in any form of operation, these may readily receive more injury than aid from the operator of limited experience.

Diagnosis.—In many cases one can recognize at first glance a perforation of the eyeball by a foreign body and determine the presence of the latter within the eye, but in others it may be difficult to find the point of entrance and to discover the foreign body itself. It frequently happens that a patient will complain of **diminution in visual power** without known cause and with positive denial of any injury, while the skilled eye of the physician, warned by the finding of a unilateral-partial cataract, will examine the eye with a magnifying glass and at once discover a positive sign of previous penetrating wound in the form of a fine linear corneal cicatrix. If the media is sufficiently transparent to permit an **ophthalmoscopic examination,** the splinter will be found in the vitreous or retina. Naturally even the most experienced surgeon may in some cases only succeed after prolonged efforts.

Often a vain search is made for the **cicatrix.** A fine narrow splinter with sharp edges, penetrating the sclera at the limbus or through the bulbar conjunctiva, will leave behind not the slightest trace of a visible cicatrix. The diagnosis will then depend upon the examination with the ophthalmoscope, the sideroscope and the Röntgen rays. An advanced cataract may render impossible the illumination of the eye ground and the consequent discovery of the foreign body. Again, the lens may remain transparent in spite of a perforating injury; namely, if the perforation has occurred through the sclera without injuring the lens. However, the diagnosis may be rendered difficult

through the presence of dense vitreous turbidity, which is usually greatest around a foreign body lodged posteriorly in the eyeball. Or the difficulty in diagnosis may be due to the separation of the retina, which occurs frequently in such injuries. An exact and complete diagnosis, including the localization of the splinter, is most readily made when the opportunity is afforded of examining the patient immediately after the injury. Under these conditions, even if the lens is pierced, it is frequently possible, in spite of beginning lenticular turbidity, to find the splinter by means of the ophthalmoscope in the vitreous or in the retina.

The position of the foreign body does not always correspond to the direction indicated by the corneal wound and the turbidity of the lens. It frequently happens that the splinter has been deprived of its momentum through resistance of the cornea and lens, and simply falls to the bottom of the vitreous chamber. On the other hand, it may have been projected as far as the retina without penetrating the latter, and may have sunk downward from the point of impact. It is, therefore, always advisable to examine first the fundus, especially in the direction of the corneal and lenticular wounds. Here there may be discovered a wound in the retina and chorioid, appearing as a glistening, white spot (the exposed sclera), which may even assume the form of the foreign body; or there may at least be seen a hemorrhage corresponding to the point of impact.

In most cases the foreign body is a splinter of **metal,** which is rendered conspicuous by its metallic **luster,** as its outer surface reflects light strongly. In recent cases, **air-bubbles** may not infrequently be seen in the vitreous or around the foreign body. If a dense opacity of the vitreous lies in front of the foreign body, the position of the latter is betrayed by a conspicuous whitish luster. In presence of iron-splinters within the eye, the **sideroscope** renders valuable assistance; it not only indicates the presence of small particles, but also at the same time allows an incidental localization, manifested by a marked deviation of the magnetic needle upon approaching the position of the fragment.

However, the deviation of the magnetic needle does not always indicate the presence of a splinter within the eyeball. We have recently seen an illustrative case in which a patient declared that he had been wounded by a splinter while hammering on iron two months previously. The splinter penetrated the lower lid about 8 mm.

below the edge of the lid. The wound bled slightly, and it was only after the lapse of some time that the patient noticed a gradual diminution in the visual power of this eye, without having experienced any inflammation. When the patient was seen for the first time, there was found a delicate scar in the skin of the lower lid about 3 mm. in length. No cicatrix could be found on the eye by the minutest examination, but the vision was about one-fourth normal. By means of the ophthalmoscope, floating vitreous opacities could be seen, which were fixed below and moved about freely in the upper part of the eyeball. Upon looking downward, the red reflex was lost entirely, on account of increasing density of the opacities. As the visual field was much limited in its upper part, a separation of the retina in this region seemed probable. The splinter could not be seen. The patient was placed in front of the sideroscope. Upon approaching it, the needle was immediately affected, and showed a marked deviation. This occurred with almost the same intensity in all positions of the eyeball, but was greatest when the patient was brought near, with the eye directed upward. But in front of the large magnet even the strongest currents did not draw out the splinter, and the patient did not have the slightest pain. This was more remarkable, since the presence of a large splinter had been assumed from the size of the palpebral cicatrix and the deviation of the sideroscope. However, examination with the Röntgen rays showed that actually a splinter 5 mm. long was lodged in the orbit outside of the eyeball. In its course through the orbit the splinter either had perforated the sclera twice, or had slit up the envelope of the eyeball below, and had thus produced the intra-ocular changes.

The **extraction of iron splinters by the magnet operation** will first be described. When the iron splinter is found in the vitreous chamber or in the retina, the method employed exclusively in our clinic consists in first drawing this splinter into the anterior chamber by means of the **large magnet (Haab)**. This operation must be carefully performed, in order that the eye shall not receive disastrous injury. There are two means at our command to lessen the attractive power of the large magnet on the eye, either by employing a weak current so that the iron core is given but slight magnetic pull, or by keeping the eye at some distance from the pole of the magnet. The object is to use the least possible magnetic force necessary to draw the splinter gently around the edge of the lens, first behind the iris and then through the pupil into the anterior chamber. If the position of the

splinter has been determined, it is not difficult to rotate the eye into the proper position. For example, if the splinter lies in the lower part of the vitreous chamber, the eye will be directed downward upon approaching the magnet, so that the latter is brought approximately opposite the center of the cornea. If the injury has occurred recently, the splinter will very soon follow the magnet, and will appear behind the iris, causing a protrusion of the latter. If the injury is of longer duration, it may take some time before the splinter yields to the traction of the magnet. If it is seen that the extraction cannot be accomplished with mild currents, the strength of the latter is gradually increased. But if the patient experiences pain even with a mild current this is an indication that the splinter is yielding, and is perhaps in contact with the ciliary body; greater care must then be taken in the operation. If the foreign body has become firmly lodged in the posterior eye-ground by means of inflammatory bands, even the large magnet may not be sufficient to dislodge it, especially if the splinter is very small. It may then be necessary to subject the patient to the magnet repeatedly, and each time for a longer period, before we succeed in drawing the splinter gradually from its bed.

Having been drawn into the anterior chamber, the splinter may be pulled by force of the magnet to the posterior wall of the cornea, where it remains hanging; or it may fall upon the iris or into the angle of the chamber, where, if sufficiently small, it may entirely disappear from view. To remove the splinter from the anterior chamber, an incision is made with the lancet, usually below, and of sufficient size so that an instrument, such as forceps or the end of a small magnet, may readily be introduced without compressing the iris or cornea. It is best to attempt to combine the incision and the extraction of the foreign body in one act. The assistant by means of the small magnet holds the splinter against the center of the posterior corneal wall, while the operator introduces the lancet. At the moment when the operator begins to withdraw the lancet from the eye, the assistant moves the magnet downward along the outer surface of the cornea, so that the splinter makes its exit from the wound along the outer surface of the lancet simultaneously with the latter.

A negative result from the examination with the sideroscope is not always to be accepted as a certainty that no steel is in the eyeball or orbit; a slight deviation may frequently have no significance, especially in large cities, where the magnetic needle is always in a state of unrest.

Penetrating wounds of the eyeball are often made with splinters of other materials, such as **wood, stone** and especially **copper,** which may penetrate the eye from an explosion of percussion caps. If these splinters lodged in the posterior section of the eyeball, until recently the eye was usually looked upon as lost; and if it was certain that such an intra-ocular foreign body was present, an enucleation was immediately performed. Examination with the **Rontgen rays** has since effected a great change in the treatment of these cases, and has made it possible to save many eyes that were formerly regarded as lost. Without a previous examination with the Röntgen rays, no operation should be undertaken in any case where there is suspicion of an intra-ocular foreign body, with perhaps the exception of an iron splinter. By this examination there is also given us accurate information concerning the position of the splinter.

Summary—In concluding these observations, it may be said in general that the presence of small wounds caused by the impact of foreign bodies usually points to the likelihood of these bodies having entered the eye; while in patients showing large wounds the injury is caused by larger pieces which rebound and do not remain in the eye. For example, if a recent injury of the cornea is found in the form of a small perforating wound, and if the history is obtained that a small splinter had come in contact with the eye, such circumstances will allow the presumption that there is a foreign body within the eye. If it is not found lying in the anterior chamber, the search for a perforation of the iris, lens-capsule, etc., will not be in vain. On the other hand, a larger piece, flying against the eye with its fine point, might wound the cornea, iris and lens-capsule and then drop away. In this case the patient's statement concerning the size of the splinter is of importance.

Unfortunately, the result with the **small magnet** is often unsatisfactory. It is not sufficiently strong to exert its magnetic power through the cornea and to direct the splinter at will. If the attempt just described is not successful, the splinter may be drawn out of the anterior chamber through the wound by means of the magnet. The tip of the magnet is introduced through the wound into the anterior chamber and brought close to the foreign body, so that the force is sufficient to attract the splinter. As the various terminals of the magnet are relatively thick, it is less injurious to grasp the foreign body directly with a pair of **forceps** and thus withdraw it. Occasionally

the splinter can be removed with the aid of **Daviel's curette.** This instrument is introduced behind the foreign body, presses it against the posterior corneal wall, and renders its extraction easy along the channel formed by the curette. In all these procedures care must be taken not to allow the splinter to disappear behind the iris, either by falling downward or by being pushed upward behind the pupil by the use of an instrument. In order to bring again to view the foreign body, recourse must usually be had again to the large magnet, especially if a minute splinter has disappeared below into the bottom of the chamber. The iris is to be excised only, if severely injured by the accident, or, as rarely occurs, it has been badly contused during the operation. If the foreign body has perforated the lens and the wound in the capsule becomes closed by the iris, the opacity in the lens may remain slight and stationary. In this case that part of the iris which covers the wound in the capsule should be carefully avoided during the operation.

Extraction from the vitreous through the anterior chamber is contraindicated only if the foreign body has penetrated the sclera behind the lens, so that the latter has remained completely transparent. In this case the splinter is withdrawn directly through the original wound by means of the large magnet, applied as described. If necessary, the wound can be enlarged to a sufficient size. Only by gross carelessness on the part of the operator will parts of the chorioid and retina be withdrawn with the foreign body. If the magnet is made sufficiently weak, the splinter can slowly be brought into the wound whence it may be readily extracted.

Some operators believe that **extraction through an opening in the sclera,** preferably between the external and inferior recti muscles, with the magnet-point between the lips of the wound, but not entered into the vitreous, is a safer procedure than removal of the foreign body around the lens into the anterior chamber. This is the method largely followed in America, the position of the metal being accurately determined by means of the Röentgen-rays before operation.

Prognosis.—The smaller the splinter, the more favorable is the prognosis for the future of the eye. Large splinters render the prognosis bad, because of the immediate injury to important parts of the eye, and the subsequent inflammation that occurs. Even though their extraction may have been performed smoothly, separation of the retina or chronic iridocyclitis may follow, usually necessitating enucleation of the eye.

Foreign bodies other than iron that lodge in the **anterior section** of the eye, may in exceptional cases be extracted through the original wound in the cornea, after its enlargement by means of scissors. Only peripheral wounds, however, are suitable for this procedure. Wounds near the center of the cornea if similarly treated would later produce still greater disturbance of vision through the larger cicatrix resulting from the incision, and it is, therefore, the best procedure to make a lancet-incision elsewhere of sufficient size to permit the introduction of forceps. This incision may be difficult if the wound produced by the foreign body has not yet closed, permitting escape of the aqueous and shallowing of the anterior chamber. But even then a correct incision can be made between the cornea and iris without wounding the latter, especially if a Graefe knife is used and is slowly introduced between both membranes. If the splinter in the anterior chamber is large and warped, care must be taken during its withdrawal not to wound the iris or capsule of the lens. The incision into the anterior chamber is best made below or externally, from which directions instruments can be most readily introduced into the eye.

The extraction from the **vitreous chamber** of foreign bodies not composed of iron is incomparably more complicated. Such substances are usually splinters of copper or grains of shot. Before operating for their removal, they must be accurately localized, using the **Roentgen rays** for this purpose. On account of their weight, most of these foreign bodies fall to the bottom of the vitreous chamber, where they immediately become fixed by exudate. They can most readily be recovered, if they lie externally and below. The **operative procedure** is as follows: After an incision into the conjunctiva and uncovering of the sclera, a meridional opening, at least 6 to 8 mm. long, is made in the neighborhood of the foreign body, the cut extending through the sclera into the vitreous humor. With double tenacula the assistant raises and separates the edges of the wound, in order to facilitate an examination of the interior of the eye. During this procedure the loss of vitreous humor can readily be avoided. It is best to have the patient in condition of profound anesthesia.

If the incision corresponds with the position of the foreign body, the latter will appear in the wound and can be removed with forceps. But if it has not appeared in the wound, the attempt to find it in the vitreous chamber is usually hopeless. The immediate neighborhood of the wound must be carefully explored with the iris-forceps, in the

hope of locating the foreign body. Occasionally, the use of **Sach's lamp** will be of material assistance in the operation. If the lamp is placed by an assistant laterally against the cornea, without exerting pressure on the eye, the open incision and the whole vitreous space is illuminated and transparent, so that in fortunate cases the foreign body is recognized as a dark structure, and can be grasped and withdrawn with the forceps. After the extraction it is necessary to suture the scleral wound accurately through the superficial layers, and to sew the conjunctiva over it. The patient should be kept in bed for several days. The prognosis even in successful cases is bad on account of detachment of the retina.

If the extraction of the foreign body has not been accomplished, it is best to proceed at once to the **enucleation.** The consent of the patient to this operation should be obtained beforehand, telling him that the other procedure is merely an attempt to save the eye through search for and extraction of the foreign body. Non-magnetic foreign bodies situated in the neighborhood of the macula give no hope of extraction with preservation of the eye.

In all recent injuries, whether the splinter is of iron or of other material, immediate operation should be undertaken. It is otherwise, however, with **old injuries.** We know that splinters of iron are not well borne, but cause a gradual disintegration of the eye through an incidious inflammation and siderosis. As extraction with the magnet is usually successful even in these old cases, the operation is always performed, especially when there are already signs of a deleterious influence exerted by the foreign body. The case is different with non-magnetic bodies in the posterior segment of the eye. Of these copper splinters are least well borne, and the attempt to remove them should be made in every case. But if such foreign body is securely lodged without signs of irritation or inflammation, the operation should be avoided on account of its unfavorable prognosis, and only undertaken if threatening phenomena arise.

CHAPTER XX.

MINOR CORNEAL OPERATIONS. PTERYGIUM. THE OPHTHALMIC ASSISTANT. ANESTHESIA.

THE OPERATIVE THERAPY OF SERPIGINOUS ULCER.

Small serpiginous ulcers may be combated by **subconjunctival injections** of a 1–1000 corrosive sublimate solution, using $\frac{1}{10}$ cc. Should no further progress of the ulcer be observed on the following day this treatment may be continued, but if the infiltration tends to spread, the **thermocautery** is to be immediately employed, since every millimeter of tissue is valuable, as the affected area is situated at or near the center of the cornea. The cautery is applied to the entire ulcer, paying especial attention to its yellow, infiltrated, progressing borders. A simultaneous **puncture of the anterior chamber** has a favorable influence on the course of the disease, and should therefore not be neglected in view of the insignificance of the procedure. It makes no difference whether or not the hypopyon is thereby removed from the eye. If the ulcer has penetrated deeply, the opening of the anterior chamber may be accomplished after first thoroughly cauterizing the whole ulcer by burning through the cornea in a punctiform spot, so that the aqueous humor trickles out slowly. The slight perforation soon closes and an adhesion of the iris is not to be feared, if the opening is in the region of the pupil.

Serpiginous ulcers that have affected more than one-third of the cornea are not longer amenable to this form of treatment, as the extensive destruction of the cornea in its whole thickness leads to perforation before completion of the cauterization, thus bringing this interference to a close. It is in these cases, and only in these cases, that we follow another procedure, i.e. **splitting the cornea** according to the **Saemisch method.** The cocainized eye is held with the forceps below, and the cornea is then split in the region of the serpiginous ulcer with a Graefe knife. In performing this operation, the knife with the cutting edge directed forward, is introduced into the healthy part of the cornea close to one edge of the ulcer, and is brought out at the opposite edge, so that the ulcer is cut through. The blade of the instrument must be

rather parallel to the cornea, in order that the lens will not be injured, as would occur if held more perpendicular and the point thus directed backward. By a slow, sawing motion, the cornea is then split in the region of the ulcer from behind forward. It is best to direct the incision so that it passes through the extending, yellow, infiltrated part of the border. The aqueous humor escapes rapidly through the incision, and the hypopyon is frequently forced into the wound, whence it can readily be extracted in a compact mass by a pair of forceps.

The opening into the anterior chamber must not be allowed to close until the ulcer has become clean and retrogressive. The **reopening of the incision in the succeeding days** is not difficult, and may be accomplished by slightly depressing one lip of the wound with a spatula. The splitting of the cornea does not always have the desired effect, and the serpiginous ulcer progresses further and destroys the whole cornea. However, a favorable result usually follows, but the operation has the disadvantage of causing extensive attachments between the cornea and the iris. These adhesions cannot be avoided, but we select the Saemisch section only in advanced serpiginous ulcers to preserve an eye that would probably otherwise be entirely ruined by the infection.

Before the patient leaves the hospital, a **broad iridectomy** is performed behind the transparent part of the cornea, to prevent the otherwise certain onset of increased pressure, which would completely do away with the visual power and cause the patient other inconveniences through the transformation of the flat cicatrix into a staphyloma. Serpiginous ulcers are frequently associated with purulent disease of the lachrymal canal, and an important part of the treatment of the corneal affection is the immediate removal of the diseased sac.

OPERATION FOR PTERYGIUM.

Transplantation of the pterygium is the simplest and at the same time the most reliable method. After well cocainizing the eye, the lids are opened with a spring-speculum, and the patient is told to look toward the side opposite to the pterygium. The operator then grasps the neck of the pterygium with toothed forceps, stretches it somewhat, and applies a lancet flat against the cornea completely separating the head (*a*) (Fig. 115) from the corneal tissue, with which it is firmly united. This peeling off must be done carefully, so that none of the advancing part of the

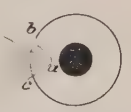

Fig. 115.—Transplantation of pterygium.

pterygium is left on the cornea. When the head is once free, the remaining loosely connected portion of the growth is separated as far as the border of the cornea and for a short distance on to the sclera. The border of the pterygium, lying at the apex of the loosened conjunctiva, is excised with the scissors, and the pterygium with its apex (*a*) turned inward so that its raw surface is directed forward and its two borders (*ab*, *ac*) diverge toward the cornea (Fig. 116). By two or three suitable sutures the borders are now united, taking care that no wound remains at the limbus. The first suture is therefore introduced vertically in the neighborhood of the limbus, it being advisable to include with the needle a few superficial fibers of the sclera between the two edges. A projection is formed on the conjunctiva by the transplanted pterygium, but in a short time it completely disappears.

Fig. 116.—Transplantation of pterygium sutures in postion.

Arlt's method for the removal of pterygium is also used frequently. The pterygium is held with toothed forceps at its neck, where it can be slightly lifted from the underlying part. The separation is the same as previously described. While none of the advancing head should be left on the cornea, no normal corneal layers should be unnecessarily removed by cutting too deeply, as this would produce a more extensive scar. After separation of the pterygium, two convergent incisions (*c b u*, *b d*) are made in its body (see Fig. 117). A rhomboidal piece is thus excised, consisting of the head and part of the body. The conjunctiva opening is accurately closed by two sutures which are introduced in a vertical position. The wound in the cornea heals by cicatrization, causing a permanent opacity. The complete and accurate closure of the wound in the conjunctivo is of great importance, otherwise the conjunctiva will again be drawn on to the cornea by the cicatricial tissue.

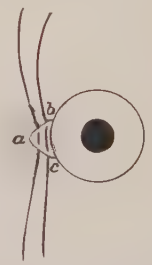

Fig. 117.—Arlt's method of operation for pretygium.

TATTOOING THE CORNEA.

Only solid, flat scars of the cornea are suitable for tattooing. If there is a tendency to ectasis or if the scar is thinned, tattooing is to be avoided. **India ink** is the only pigment applicable for the pur-

pose. It is introduced into the corneal scar by pricking either with a **cluster of needles,** or with a **single, broad needle,** provided with a groove for holding the coloring matter. In order to produce the best results, the tattooing must usually be done in several sittings. Thorough cocainization is always necessary. To hold the eye steady, the conjunctiva should be grasped with slightly roughened forceps, as toothed forceps produce slight wounds which become impregnated with the pigment.

Tattooing with the cluster of needles is to be preferred to that done with the grooved needle. The latter is better suited, however, for accurate definition of the border. With the cluster of needles which are put in vertically, the operator produces simultaneously a series of closely-placed points, and, therefore, works more rapidly. There is also less danger of perforating the cornea than with the grooved needle, which has to be applied in a slanting direction to prevent perforation. If the latter should accidently be produced and the pigment enters the anterior chamber, it must be opened with a lancet and washed out.

Froehlich's method is an excellent procedure for imitating a beautiful, round, black pupil. It is recommended for very large and thick, flat scars. With a **v. Hippel trephine** a superficial furrow is cut, corresponding in position and size to the pupil of the other eye. Then, with a lancet applied on the flat, the superficial layers of the cicatrix, containing epithelium and a few lamellæ, are removed in the form of a disk. The exposed base is scarified in all directions with the cutting edge of the lancet and the ink is rubbed in well. In this way a pronounced and uniformly black pupil is produced, which closely resembles a true pupil. The surroundings are then tattooed by pricking with the cluster of needles until the desired shade is produced.

OPERATION FOR CORNEAL STAPHYLOMA.

The method of Beer-Wecker is employed for the removal of a complete corneal staphyloma. The conjunctiva is detached completely around the limbus, as in the operation for enucleation, is thoroughly undermined, and a purse-string suture introduced which is at first left loose. The epithelium on the limbus and the border of the staphyloma is then carefully denuded, in order to produce a raw surface to which the conjunctiva can adhere when drawn over it. The staphyloma is then cut away; in doing this the lower half is first separated by

means of a Graefe knife in the same manner as for a cataract-operation. The flap thus formed is held by forceps and the upper half is separated with the scissors. A narrow band should be left above and below, through which sutures are introduced and left loose. Before tying the sutures, the lens is allowed to escape from the eye by opening the lens-capsule; after which the sutures are rapidly drawn together to avoid loss of the vitreous humor. Then the wound in the conjunctiva is closed by drawing upon the purse-string suture.

In a recent staphyloma with thin walls an attempt may be made to produce a flat scar by simply **splitting the staphyloma.** In this operation it is best to make a bow-shaped incision like that for cataract, so that the flap is formed from the wall of the staphyloma. By retraction of the flap, the wound is made to gape, which effect may be increased by excising a narrow edge from the flap. The lens is removed by rupture of the anterior capsule. Then by means of a compress and bandage, a flat cicatrix may be produced.

The incision of a staphyloma has only one advantage over enucleation, namely, that the patient is left with a freely movable stump, upon which an artificial eye can be well fitted. On the other hand, the operation has the disadvantage of not guarding against **sympathetic ophthalmia.** It is, therefore, evident that enucleation should be preferred in all cases in which there is suspicion of sympathetic ophthalmia or in which the latter may readily develop.

EXPRESSION OF TRACHOMA-GRANULES.

This operation is performed under cocain-anesthesia. After repeated instillation of the cocain-solution into the conjunctival sac, a sub-conjunctival injection of a 1 per cent. cocain-solution is made beneath that part of the conjunctiva upon which the expression is to be commenced. The conjunctiva over the granules is then superficially scarified with a Graefe knife, so that the granules may readily make their exit through the slight incisions thus produced. In order to gain comfortable access to the upper fold, the lid is everted. Moreover, the sub-conjunctival injection causes a marked swelling and protrusion of the fold. For expression of the granulations we employ either Knapp's roller-forceps or Kuhnt's expresser.

In using **Knapp's roller-forceps,** the conjunctival fold is grasped between the two branches, one end of the roller-forceps being introduced

above between the scleral conjunctiva and that of the lid, while the other end is placed upon the anterior surface of the tarsus. The instrument is pressed together rather forcibly and is drawn slowly along the conjunctiva. During this procedure the ridged rollers pass over the conjunctiva and express the granulations. The traction should not be made rapidly, as this may produce more marked lesions of the conjunctiva in the form of lacerations, and give rise to fresh scar-formation. The more carefully the operation is done, the less painful will it be and less injurious to the conjunctiva. The considerable bleeding which follows is combated by active sponging with a weak bichlorid-solution.

In a similar manner the lower lid is freed of its granulations. With Knapp's roller it is more difficult to strip the semi unar fold, and especially to squeeze out isolated granulations, without including and compressing the surrounding conjunctiva. For these cases it is best to employ simply a small forceps, the narrow branches of which can readily grasp and express isolated granulations. If a group of granulations is found on a sharply circumscribed area of the upper fold or elsewhere, we usually excise this part of the conjunctiva. On the other hand, we prefer the method of expression in those cases in which the granular formation, though sharply circumscribed, includes the whole length of the fold. In order to extract the granulations from the tarsal conjunctiva, the tarsus itself must be seized between the branches of the roller-forceps.

With **Kuhnt's expressor** the granulations are pressed out of the conjunctiva without pulling on the latter. The advantage of this instrument, therefore, lies in the avoidance of the lesions which occasionally follow laceration of the conjunctiva. Kuhnt recommends the instrument especially for advanced, felty trachoma, as in these cases the conjunctiva of the transitional fold is easily lacerated and wounded by the rolling, on account of the felty change. The unpleasant result of this injury would be a marked contraction of the conjunctival sac. With Kuhnt's expressor all pulling and lacerating of the conjunctiva is avoided, and the granulations are pressed out of their beds like comedones.

After expression, cold compresses should be applied diligently for several hours. After an interval of about two days, the further medical treatment of the conjunctival disease may be commenced, i.e., touching with 2 per cent. silver-nitrate solution.

THE OPHTHALMIC ASSISTANT.

In order to obtain free access to the eye with the instruments during operations, the lids must be adequately opened. In those operations in which the eyeball is not cut into or is incised only to a slight extent, we employ the spring-speculum. It is, therefore, used in strabismus-operations, in pterygium-operations, discissions, puncture of the anterior chamber, etc. On the other hand, we dispense with the use of the speculum in iridectomy for glaucoma and in cataract-operations. Even those operators who regularly use the **lid-speculum** designate it as "an instrument dangerous to the eye, but indispensable" (Terrien). The first attribute is correct, but not the second. The lid-speculum will cause no injury in a patient who is quiet and who does not twitch, especially if the assistant holds it carefully in his hand and directs it so that there is no pressure exerted on the eye. In any case, the lid-speculum often becomes a great hindrance; indeed, with a small palpebral fissure it may render impossible, for example, an upward incision. The injury produced by introduction of the lid-speculum may even amount to a catastrophe if the patient strains, the wound begins to gape, and the vitreous humor presents itself. In addition, it may then become very difficult to free the lids from the instrument. In Mueller's lid-speculum, the branches are turned around by closure of the speculum so that the lids free themselves. If the operator can command the services of even a half-experienced assistant, this is certainly to be preferred over the lid-speculum.

The work of the assistant consists in separating the lids and holding the palpebral fissure open only during the short periods that the operator works on the eye. In the intervals, while the instruments are being changed, the eye washed out, etc., the lids are released so that they cover the eye.

In opening the palpebral fissure (see p. 125), the assistant applies the thumb of the right hand to the edge of the superior lid, raising it and at the same time pushes the lower lid down with a finger of the left hand laid on its edge. The upper lid is at the same time somewhat drawn away from the globe, so that its border does not get into the wound if the eye should be suddenly rotated upward or if the lid should suddenly slip. The lower lid should be pushed downward in such manner that it does not roll outward. The extent of separation of the lids depends upon the operative procedure to be undertaken.

The work of the assistant **during a cataract-operation** may be detailed as follows: During the incision, the palpebral fissure is held open as just described. When the operator has completed the incision, the assistant lets the upper lid slide down, in such a manner that it does not make the wound gape. It must, therefore, be brought down at a certain distance from the cornea in the sagittal plane. This is best accomplished by drawing the external canthus somewhat downward, whereby the upper lid performs the desired movement. The lower lid must not be released until the upper lid covers the wound.

In performing the **iridectomy** the palpebral fissure is opened in the same way, and the assistant need only see that the finger which holds the upper lid is not placed in the way of the operator (see Fig. 60 of

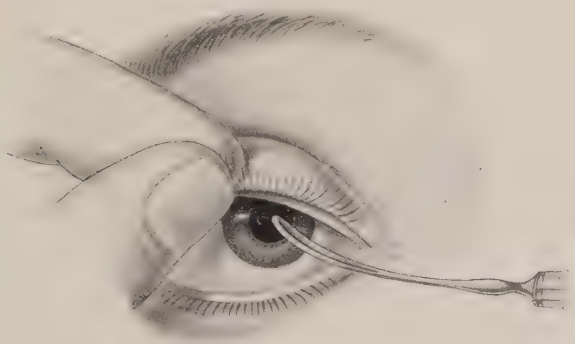

Fig. 118.—Assistance. The operator grasps the upper lid by its cilia, draws it slightly away from the eyeball, and guides it downward over the wound, while the spoon is inserted under the lid to keep it away from the surface of the globe.

the cataract-operation, p. 125). As the operator must introduce the forceps into the wound from above, the assistant places his finger on the lid either internally or externally.

In **opening the anterior capsule,** the operator himself raises the upper lid with the left hand. The assistant holds the lower lid with one hand, and at the same time takes a Daviel spoon in the other hand, which is held against the border of the upper lid. If the lid should slip through the fault of the operator or from the twitching of the patient, it will fall upon the spoon, and will thus slide over the wound without turning the latter back. At the critical moment the operator can help himself without much chance of failure, by slipping the rapidly closed capsule forceps under the upper lid and thus drawing it down. Fig. 118 shows how the operator himself may draw down the

lid by its cilia, while the spoon in the assistant's hand is ready to slip under the lid and hold it away from the eye.

Control of the lower lid always requires great care. Even though the patient twitches but slightly, the lower lid should never remain without fixation after the upper lid is raised. If the lower lid is left free, and the patient makes it tense through innervation of the palpebral muscle, the lid will be pressed against the globe and will cause the wound to gape and open. The vitreous humor may even be expressed in this way.

If the operator contemplates **removing the lens in its capsule,** on account of thickening of the latter, he should allow the assistant to hold both lids, so that he himself may take in his left hand the spatula with which the scleral edge of the wound is somewhat depressed to favor the escape of the lens.

During **expression of the cataract** the operator, while raising the upper lid with either hand performs with the lower lid the massage-movements that have been described for expressing the lens. The assistant holds the Daviel spoon, prepared to introduce it under the upper lid, if necessary, and to extract the lens when it protrudes to the extent of one-half. In performing this latter act, the spoon is placed against the equator of the lens and thus lifts it out.

During **reposition of the iris** the operator raises the upper lid and the assistant holds the lower. If the patients are quiet and do not twitch, the assistant's task is an easy one. Of course, the assistant must never press the lids against the eye. In protruding eyes the opening of the lids requires special care. The lids must not be pushed far backward, but must be opened merely enough for the requirements of the operator. The work of the assistant is much more difficult in the case of a patient who strains. But it is just in such cases that the value of a good assistant is fully appreciated. Skillful separation of the lids in the correct manner and at the right time often prevents the otherwise certain prolapse of the vitreous humor.

In **unruly patients** it may be quite impossible to proceed in the manner described. The upper lid must then be elevated by inserting a **Desmarres elevator.** All pressure on the eye, however, must be carefully avoided. This elevator is permitted to remain in place during the whole operation, while the lower lid must also be fixed at the same time, for reasons that have been mentioned. The only disadvantage of the elevator is that it stands in the way of instruments

that are to be introduced from above. The spring speculum, however, must never be used in restless patients.

If a **prolapse of the vitreous** occurs, the lids must not be aimlessly released, as is often done by frightened assistants. On the contrary, the upper lid still firmly held must be cautiously lowered over the gaping wound, while the operator inserts under the lid for its guidance the instrument which he happens to have in his hand. This may be a closed pair of Wecker's scissors, the capsule-forceps, the spatula, the spoon, or even the handle of the Graefe knife. The lower lid may be released by the assistant only after the upper lid has covered the wound. Otherwise the patient will raise the flap still further with his lower lid, and will thus express the vitreous. In patients who are known beforehand to be restless and likely to twitch, the opening of the lids may be materially facilitated by performing an extensive canthotomy immediately before the operation.

Occasionally it may also fall to the lot of the assistant to hold the eye with **fixation-forceps.** As repeatedly stated, fixation is only employed in cataract-operation while making the incision. In non-congested and well-cocainized eyes, the iridectomy is usually accompanied by so little pain that the patients are perfectly quiet during its performance. After opening the eyeball by a long incision, the use of fixation-forceps, even with the greatest care, causes a gaping of the wound. The fixation-forceps should only be employed when absolutely necessary. Especially in the cataract-operation their use can only be forced by unreasonable patients. In such cases the assistant applies the forceps to the limbus exactly at the lower edge of the cornea, and draws the eye slightly down. The forceps also keep the lower lid away from the globe. The iridectomy may under these circumstances become difficult.

If the upper lid is held up by the **Daviel spoon,** the eyeball must be carefully drawn downward a little with the forceps; otherwise, it may be impossible in the small space to draw out the iris with the forceps. On the other hand it may be easier to slip into the anterior chamber from the side with a properly bent, blunt tenaculum, and thus draw out and excise a fold of iris from the pupillary border. Likewise the opening of the anterior lens-capsule must then be performed with a sharp tenaculum that has been bent in the required direction. The otherwise painful excision of the iris in inflammatory glaucoma, injuries, prolapse of the iris, etc., may be rendered considerably less

painful by dropping a little cocain-solution on the exposed iris after the anterior chamber is opened. However, in certain cases the eye must be held with the forceps in order to be quite safe, and this we do almost regularly in excision of a prolapsed iris in an inflamed eye. During reposition of the iris it may be necessary to draw the eye downward with the forceps, because the patient will not voluntarily look down. In this case it is best for the operator himself to hold the eye in the required position.

As already mentioned, the eye must be held fast in all procedures with cutting or puncturing instruments, e.g., during the incision, during discission, etc. Occasionally an exception can be made in very quiet patients who will turn their eyes in the required direction. For example, if the conjunctiva tears away during the incision, and if the patient looks in the right direction, there is no objection to completing the incision without further fixation. A discission, the incision in a linear extraction, or a puncture may exceptionally be performed without fixation.

Beside proper fixation, the **position of the operator's fingers** is important. The support of the **operator's hand** must also be at a safe point. For this purpose, the fourth finger of the hands usually rests in a suitable position on the head of the patient. In incisions from the external side the operator's hand is supported on the temple or malar bone. In incisions from below, the hand is supported on the cheek; and in incisions from above, on the forehead. The operator is not then taken unaware by an unexpected movement of the patient's head. The incision directed downward is the more readily accomplished because every patient shows a tendency to avoid the instrument by an upward movement of the eye, and it is usually much easier to look upward than downward.

It was, therefore, repeatedly recommended to perform all ophthalmic operations, including cataract-extraction, by the **inferior incision**, and in fact, special methods were devised for this purpose, but, as iridectomy must be performed in most cases, operators soon adhered to the upward cut. In fact, in the establishment of a broad coloboma for glaucoma, it is of importance that the coloboma be covered by the upper lid. The lower operations are therefore limited to those cases in which it is known beforehand that a coloboma will not be necessary, such as puncture of the cornea, linear extraction and similar operations. There are, however, certain cases which are especially suitable

for the inferior operation. In cataract-patients an accompanying ptosis may cause the pupillary region to be covered by the upper lid, an amyotrophic ptosis being not uncommon in old persons. This is an indication for the inferior operation with a narrow coloboma, avoiding the periphery of the iris.

Auxiliary minor assistance may be serviceable during an operation. It is the duty of the assistant to remove the blood from the conjunctival sac by **sponging.** The sponges should be kept in sterilized, physiologic saline solution. The sponge is well squeezed out and one end is formed into a point. This end is inserted into the internal angle of the eye so that it absorbs the blood from the point outward; or the end may be drawn from the internal angle outward along the inferior transitional fold, taking the blood with it. Direct sponging of the operation-wound in the eye is to be avoided as much as possible. With marked hemorrhage into the anterior chamber it will serve the purpose very well if the assistant strokes the blood out of the anterior chamber, while the operator stands ready with the instrument to perform rapidly the next operation (iridectomy or opening of the capsule) as soon as he can obtain a clear view of the chamber.

If necessary, the assistant should turn the **conjunctival flap** back with a spatula, in case it should get in the way of the operator. He should stroke the iris back into its place, if, during an extraction without iridectomy, the border of the pupil should become stretched against the lens as it makes its exit. Occasionally it may be necessary for the assistant to cut off the iris with the **de Wecker scissors,** if the operator, for example, in the excision of a prolapsed iris, holds and directs the eye with one hand while the other hand draws out the iris.

ANESTHESIA.

In all ophthalmic operations there is an advantage in being able to operate under **local anesthesia.** We use it on the most extensive scale, and endeavor to make it suffice wherever possible in the place of general anesthesia. In most operations on the eyeball itself, the co-operation of the patient in bringing the eye into the proper position will make the procedure much less difficult and will render unnecessary the dangerous fixation of the eye during many operations. General anesthesia not only robs us of this factor, which is important for the faultless accomplishment of many operations, but also draws in its train another series of baneful influences which are important in

patients subjected to any eye operation. Among these latter may be mentioned the dulled consciousness, the restlessness of the patient upon awakening, the often violent vomiting, etc.

General anesthesia is therefore confined to the following cases:

1. Children who do not as yet possess sufficient intelligence to keep quiet and conduct themselves sensibly.

2. More extensive operations in the orbit and on the lids, especially if the parts subjected to operation are sensitive on account of inflammatory conditions, such as exenteration, enucleation of inflamed eyes, more extensive plastic operations and similar procedures.

3. Severe operations on the eye itself, if local anesthesia is refused (especially in inflammatory glaucoma, excision of prolapsed iris in marked inflammatory conditions, etc.) or if the patient is not suitable for local anesthesia on account of other circumstances, such a pronounced blepharospasm, dementia, great irritability, etc.

Cocain-anesthesia in operations on the eye itself is usually effected by a 3 per cent. solution, which is dropped into the eye several times during a period of ten minutes. The eye must be kept closed during this process of cocainization. If it remains open, the cocain may readily produce a dryness of the cornea with epithelial changes, which may not only impede the operation on account of cloudiness of the cornea, but may also cause the patient pain after the operation. If the eye is injected, a few drops of **adrenalin-solution** should be instilled in the eye. The last application should be made just before the operation, as the constriction of the vessels caused by the adrenalin soon disappears and is replaced by a vascular relaxation which might cause considerable bleeding during the operation.

The advantages of cocain surpass those of all its substitutes. Its constricting influence on the vessels is an excellent property, which is of great value in every operation. The dilatation of the pupil which it causes is undesirable only in glaucoma-operations, but can usually be prevented by a preceding instillation of eserin. Recently we have substituted for cocain in these cases a 3 per cent. solution of **alypin,** which must be supplemented by adrenalin, as it does not possess any vaso-constrictor properties. We also prefer alypin for sounding, for extraction of foreign bodies from the surface of the cornea, etc., as it does not cause the patient the inconvenience of pupillary dilatation.

To produce a more profound anesthesia of the deeper parts of the eye, we drop some **cocain-solution into the anterior chamber**

after it is opened in cases in which manipulation of the iris will presumably be painful, as in inflamed eyes. For this purpose only a sterilized solution can be used. For operations on the lids a **subcutaneous injection of a 1 per cent. cocain-solution** will usually suffice. The injected fluid must be suitably distributed throughout the field of operation.

The addition of **adrenalin** (3 to 5 drops) to the cocain-solution will reduce the bleeding to a minimum. More accurate directions have been given with the various operations, so that the best effect can be produced with the least quantities. Aimless injection in one place with neglect of other parts of the operative field will not produce the desired result. The **dose of cocain** which we employ in most operations is a minimal one, amounting at most to one Pravaz syringeful (0.01 gm. cocain), so that poisoning need not be feared in the most sensitive individuals. Only in enucleation is as much as 0.03 gram allotted, a quantity which is also far below the maximum dose.

In place of general chloroform or ether narcosis, the **general anesthesia with scopolamin and morphin** is recommended, carried out according to the following prescription. These solutions should be freshly prepared each time:

℞

Scopolamin. hydrobromat,	0.01
Aq. destillat	30.0

℞

Morphin. hydrochlr.,	0.075
Aq. destillat	9.0

Three hours before the operation one cc of each solution is injected under the skin of the upper arm, first injecting one solution, and then, without withdrawing the needle, making the other injection in the same place, but in another direction. Even after these injections the patient will become somnolent, quiet and so insensible of pain that the operation can often be performed in this stage with the aid of simultaneous cocainization of the eye. But if the desired effect is not obtained, the same dose of each solution must again be injected fifteen minutes before the operation. Thereupon the patient can be subjected to the operation in a completely relaxed condition, if at the same time the eye is made insensible by cocain. The advantage of this method is that the patient sleeps quietly for several hours after

the operation, does not vomit and exhibits no restlessness upon awakening. Moreover, after carrying out these methods, a general narcosis can be rapidly produced by a few drops of ether or chloroform.

Bandaging After Operations on the Eye.—We employ **Fuchs' lattice** in men, and **Snellen's cup** in women, the cup being attached by strips of **adhesive.** The latter is not advisable for men, because the plaster will not adhere to the bearded skin. In children and restless patients **bandages** are applied, and with the aid of **starch** a stiff dressing is produced, which will also sufficiently protect the eye against careless contact. The application of **pressure-bandages** has been described in connection with the operations in which they are indicated.

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